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ABSTRACT

This document presents an analytical bibliography of literature on the library of the future that was published between the years 1983 and 1994. This project had four objectives: (1) to identify and retrieve published literature on the library of the future; (2) to formulate document surrogates for this literature and add them to a computerized database; (3) to generate an analytical bibliography of published library of the future literature; and (4) to synthesize literature in the bibliography with a thinkpiece on the topic. The introduction provides background information and describes the project methodology, coverage, and key early works. The key findings, claims, or recommendations are then presented with author commentary in the following areas: digital libraries; phases in the application of information technology to libraries; print-based technology; tools for accessing digital libraries; digital library models; stakeholder motivations and concerns; digital library projects; libraries of the future; and harnessing the true potential of information technology. Two essays conclude the report: "Whither Libraries?" and "A Sense of Urgency." Contains 220 references. A combined author subject index is included. (JLB)

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Analytical Review of the Library of the Future

by

Karen M. Drabenstott

with the research assistance of Celeste M. Burman

Council on Library Resources

February 1994

IR055248

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Published (bound and printed) copies of *Analytical Review of the Library of the Future* may be obtained from the Council on Library Resources for $15.00 prepaid. Diskettes (3.5-inch) of the ProCite bibliography of the library of the future literature may be obtained from the Council on Library Resources for $5.00 prepaid. Please consult the title page of *Analytical Review* for the address of the Council on Library Resources.

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1 Introduction

1.1 Background

During the last few years, a wide variety of organizations have begun to explore the concept of a library of the future (or digital library). Groups including the National Science Foundation (NSF), American Association of University Presidents (AAUP), Research Libraries Group (RLG), Xerox Corporation, Coalition for Networked Information (CNI), and Commission on Preservation and Access have sponsored meetings and initiatives designed to help participants consider the digital library. Publishers are also investigating the digital library concept because the cost of creating print products has increased substantially in recent years and subscriptions are decreasing, especially subscriptions to scholarly journals. The diversity and number of these groups indicates the growing awareness that some components of a digital library can be implemented immediately but others require profound social, organizational and financial changes that will require careful rethinking of the current dominant paper-based means of accessing information to create new access forms freed from physical space and temporal restrictions.

This emergence of so many diverse groups involved in the exploration of the digital library concept suggests that enough of the enabling technologies are now available and affordable to spark genuine interest in testing new forms of information capture, management and retrieval. At the same time, the increasing cost of paper-based journals and books and the library buildings to hold them have generated strong interest among university administrators to identify alternative approaches.

It becomes increasingly difficult to keep informed of the scholarly research and development of all those exploring and implementing ideas related to the library of the future because much of the discussion extends beyond literature published in traditional formats such as printed books, newsletters, and journals to electronic resources such as bulletin boards, mailing lists, newsgroups, and electronic publications. By keeping abreast of new developments, librarians can shape the future, lay claim to crucial roles, and ensure that the new digital libraries reflect their own values and are not replaced by those of other professions.

Recognizing the growing importance of the library of the future and the burgeoning literature on this topic, the principal investigator of this project and the president of

the Council on Library Resources discussed the idea of preparing an analytical bibliography of published literature on the library of the future. After support from the Council enabled the authors to begin this project in April 1993, a key development in this area occurred in September 1993 with the announcement of the Digital Libraries Initiative, a joint initiative of NSF, the Advanced Research Projects Agency (ARPA), and the National Aeronautics and Space Administration (NASA) ("Research on digital libraries" 1993). Not only will this initiative provide significant funding and leadership for research fundamental to the development of digital libraries, it will mark a significant investment in the establishment of digital libraries that will extend far beyond the term of the initiative.

1.2 Project objectives

Support from the Council enabled the authors of this analytical bibliography to achieve the following four project objectives:

1. To identify and retrieve published literature on the library of the future.
2. To formulate document surrogates for this literature and add them to a computerized database.
3. To generate an analytical bibliography of published library of the future literature.
4. To synthesize literature in the bibliography with a thinkpiece on the library of the future.

1.3 Methodology

To achieve the project's first objective, the authors searched commercially-available databases (i.e., ERIC, LISA, ISA, Library Literature, OCLC Online Union Catalog, Current Library) on the Dialog, Wilsonline, EPIC, and NEXIS retrieval systems, respectively, for citations to literature published during a ten-year period between 1983 and 1994. They also solicited citations from SILS faculty and affiliates. The authors retrieved published literature from library collections of the University of Michigan, Wayne State University, and Detroit Public Library, and from interlibrary loan requests. They also reviewed selected electronic journals and newsletters such as PACS-L Review and Current Cites to find material on the library of the future.

To accomplish the project's second objective, the authors read retrieved material, formulated document surrogates consisting of citations, descriptors, and abstracts, and built a ProCite database containing these surrogates. They assigned descriptors to ProCite-based document surrogates based on the *Thesaurus of ERIC Descriptors*.

Abstracts in ProCite document surrogates are based on the original abstract in database from which citations were retrieved. In the absence of abstracts, the authors composed abstracts that summarized articles' key findings, claims, or recommendations. There are about 375 document surrogates on library of the future literature in the ProCite database.

This report fulfills the project's third and fourth objectives. The purpose of the report is to give an analytical bibliography of published literature on the library of the future and synthesize referenced literature with a thinkpiece on the library of the future.

The authors intended the organization of this report to be similar to *Analytical review of catalog use studies* in which an introduction described the literature on catalog use studies and summarized studies according to findings that supported or failed to support a particular hypothesis (Markey 1980). This report's organization differs from the earlier *Analytical review* because library of the future literature is not focused on testing hypotheses. Most literature speculates about the future or describes pilot projects that will help shape the future. The authors organized the literature on the library of the future by identifying key findings, claims, or recommendations, placing them into the left-hand column of a topical outline, and adding commentary to the right-hand column.

This report has six major components: (1) topical outline, (2) introduction, (3) key findings, claims, or recommendations with author commentary, (4) thinkpiece on the library of the future, (5) bibliography of cited literature, and (6) index. The table of contents serves as the topical outline to key findings, claims, or recommendations. Section 1 of this report is the introduction. Sections 2 to 8 and 10 to 11, use the topical outline to organize selections that address key findings, claims, or recommendations, and provide commentary adjacent to exact or paraphrased selections. Following such selections are references to authors whose publications support the point under discussion. Section 9 summarizes important digital library projects. Section 12 is the thinkpiece on libraries of the future. Concluding statements are given in section 13. A bibliography of literature cited in this report is given in section 14. (The ProCite database contains about 375 document surrogates to published literature on the library of the future; this report cites over half of this literature.) A combined author-subject index concludes this report.

1.4 Coverage

The authors tried to be comprehensive about covering published literature on the library of the future during a ten-year period between the years 1983 and 1994. They began their literature search on April 1, 1993. Since completing the literature search and a draft of this report on November 30, 1993, important new reports such

as *Accessibility and integrity of networked information collections* by Clifford A. Lynch (Washington, D.C.: Congress of the United States, Office of Technology Assessment, 1993) and *Source book on digital Libraries* by E. A. Fox (Blacksburg, Va.: Virginia Technical Institute, 1993) have come to their attention. Despite the authors' attempts to be comprehensive about covering important works published between 1983 and 1994, they apologize for inadvertent omissions.

In their literature search, the authors focused on literature emanating from the library and publishing communities. In the course of their literature search, they recognized that the library of the future topic was especially affected by developments in electronic publishing and included selected works on electronic publishing in this review. The authors suggest that the Council on Library Resources give consideration to reviews of related areas — electronic publishing, enabling technologies, library and information science education, intellectual property, collaboratories, digital books — to increase our understanding of the library of the future.

1.5 Key early works

Today's writers on the digital library have been inspired by early (real or imagined) conceptions of digital libraries. Writing in *Atlantic Monthly* almost fifty years ago, Vannevar Bush (1945) described the memex, an idea that conjures up images of today's conceptions of the library of the future:

> A memex is a device in which an individual stores all his books, records, and communications, and which is mechanized so that it may be consulted with exceeding speed and flexibility ... It consists of a desk, and while it can presumably be operated from a distance, it is primarily the piece of furniture at which he works. On the top are slanting translucent screens on which material can be projected for convenient reading. There is a keyboard, and sets of buttons and levers. Otherwise it looks like an ordinary desk ... Most of the memex contents are purchased on microfilm ready for insertion. Books of all sorts, pictures, current periodicals, newspapers, are thus obtained and dropped into place. Business correspondence takes the same path. And there is provision for direct entry ... If the user wishes to consult a certain book, he taps its code on the keyboard, and the title page of the book promptly appears before him, projected onto one of his viewing positions ... Any given book of his library can thus be called up and consulted with far greater facility than if it were taken from a shelf ... He can add marginal notes and comments ...

Twenty years later, participants at the planning conference for the CLR-sponsored Project Intrex brainstormed on applying the "technology of the day" to the problem of managing the burgeoning scientific literature. Based at the Massachusetts Institute of Technology (MIT), Project Intrex had two objectives: (1) "finding long-term solutions for the operational problems of large libraries," and (2) "developing

competence in the emerging field of information transfer engineering in close concert with the MIT libraries" (Overhage and Harman 1965, 1). Project Intrex participants (Overhage and Harman 1965, 1) described a future scenario of information seeking that is similar to today's vision of the digital library:

> The library will be the central resource of an information transfer network that will extend throughout the academic community. Students and scholars will use this system not only to locate books and documents in the library, but also to gain access to the university's total information resources, through Touch-Tone telephones, teletypewriter keyboards, television-like displays, and quickly made copies. The users of the network will communicate with each other as well as with the library; data just obtained in the laboratory and comments made by observers will be as easily available as the text of books in the library or documents in the departmental files. The information traffic will be controlled by means of the university's time-shared computer utility in much the same way in which today's verbal communications are handled by the campus telephone exchange. Long-distance service will connect the university's information transfer network with sources and users elsewhere.

J. C. R. Licklider published his monograph entitled *Libraries of the future* in the same year as the planning conference on Project Intrex. Licklider's (1965, v) CLR-sponsored "inquiry into the applicability of some of the newer techniques for handling information to ... library work" introduces readers to an advanced system called the Symbiont which enables individuals to search databases, browse machine-readable documents, extract or highlight passages of text, annotate documents, compose graphs from numeric data, and perform many other tasks connected with text or data manipulation.

In 1978, F. W. Lancaster promulgated the idea of a paperless society in a monograph entitled *Toward paperless information systems*. Drawing inspiration from the intelligence community's shift to "fully electronic systems," Lancaster (1965, xi) "summarize[d] the achievements of the intelligence community in the implementation of paperless systems, point[ed] to the need for such systems in the scientific and technical community, and present[ed] a scenario of what a system of this type might look like."

Selections from Bush, Project Intrex, Licklider, and Lancaster demonstrate that something resembling a digital library has been envisioned by writers for some time. This report provides evidence that tremendous advances in information technology could bring digital library visions to life by the turn of the century. At the same time today's writers are putting new technology to work at solving the problems of the digital libraries, they are also grappling with the many other issues — legal, social, cultural, economic — that must be resolved before the digital library becomes reality.

1.6 The need for an analytical review

- "Someone ought to be willing to go back over the recent history of libraries and pull together all the articles in which authors have speculated about the future of libraries. With all that information in hand our 'someone' could then extract all the predictions and match them up with the actual outcomes to see just how accurately librarians have been able to predict their future. That's an onerous task that I wouldn't wish on anybody ..."

  (Alley 1990, 576)

Although "someone" may visit this review at a later date to match up the predictions in this report with the future, the authors hope that librarians read this analytical review to keep abreast of new developments — especially speculation about the future and digital library pilot projects — so that they can shape the future, lay claim to crucial roles, and ensure that new digital libraries reflect their own values and are not replaced by values of other professions.

2 A shared vision of the future

- "There is an evolving shared vision of the new information world. It is a world of ubiquitous, reasonably priced digital information in any and all media, available to everyone from a computer, television, palm, or wrist, as predictable, ordinary, and universal as a toaster."

  (Garrett 1993, 18)

The authors have adopted John Garrett's shared vision statement and treat it as an assumption throughout this report.

3 Digital libraries

3.1 Definitions

- "The ideal electronic library is not a single entity where everything is stored, it is a range of services and collections made accessible through networks that reach beyond individual campus or research laboratories."

  (Kibby and Evans 1989, 16)

- "The *virtual library* is a system by which a user may connect transparently to remote libraries and databases using the local library's online catalog or a university or network computer as a gateway."

  (Saunders 1992b, 66)

- "Virtual libraries are collections of materials about which a user can learn through systems developed by the library, and which the library can then obtain for the user."

  (Lynch 1991, 77)

- "The virtual library has been defined as the concept of remote access to the contents and services of libraries and other information resources, combining an on-site collection of current and heavily used materials in both print and electronic form, with an electronic network which provides access to, and delivery from, external worldwide library and commercial information and knowledge sources. In essence, the user is provided the effect of a library which is a synergy created by bringing together technologically the resources of many, many libraries and information services."

  (Gapen 1993, 1)

Over a dozen definitions are listed here. They use the terms "digital library," "electronic library," "virtual library," "library without walls," and "bionic library" to refer to the library of the future. While the authors of this report do not prefer one definition over another, they feel it is important to summarize commonalities in these definitions:

- The digital library is not a single entity.
- The digital library requires technology to link the resources of many, many digital libraries and information services.
- Transparent to end users are the linkages between the many digital libraries and information services.
- Universal access to digital libraries and information services is a goal.
- Digital library collections are not limited to document surrogates; they extend to digital artifacts that cannot be represented or distributed in printed formats.

- "I suggest that the state that libraries have already achieved, and the direction in which they will continue to evolve, is that of the *bionic* library — the traditional library organism electronically enhanced."

  (Billings 1991b, 4)

- "The electronic library can be thought of as a new strategy for delivering information where the full text of documents is available online. The library can be accessed remotely from any location through a network using personal or portable computers. Universal accessibility represents the most revolutionary aspect of the electronic library. The contents of the library, virtual books, no longer suffer from the constraints of their physical counterparts and can be replicated as many times as required. The library itself has infinite space and there is no limit to the number of books the library can contain. Individual libraries may be interconnected in a transparent way."

  (Landoni, Catenazzi, and Gibb 1993, 176)

- "The library of the future will be a network of knowledge systems in which people and machines collaborate."

  (Feigenbaum 1989, 122)

- "The library of the future will be an on-line network of librarians — generalists and specialists. Each and every one of them will be expert in catalogue indexes and searching. Each will be connected and linked to massive computer databases. Together they will act as a master network (covering every conceivable subject — just like book libraries). The databases consist of multimedia files including full text, digital images, audio, audio-visual, animation as well as ordinary files consisting of text and images ... Instead of 'going to the library,' or calling the database service via computer modem, users will stand in front of their televideo phone. The primary input device for search requests will be the microphone. The terminals on both ends will be equipped with broadcast video camera, speech synthesizers and special modem interface software."

  (Eagle 1992, 99)

- "'Library' as a place, will give way to 'library' as a transparent knowledge network providing 'intelligent' services to business and education through specialized librarians and merging information technologies."

  (Murr and Williams 1987, 7)

- "The virtual library is the 'library without walls,' but with instantaneous electronic connections to libraries, individuals, institutions, and commercial firms worldwide. It is access to a reservoir of intellectual resources encompassing not only formal libraries, but also databases, electronic texts, multimedia objects, and potentially millions of interacting human minds."

  (Beiser 1992, 26)

- "The concept of the virtual library, i.e., a library that provides access to electronic and print materials from many sources, both local and remote, has achieved a widespread popularity."

  (Dougherty and Hughes 1991, 4)

- "Most recently, the term 'virtual library' has been applied to a vision of the library of the twenty-first century in which computer and telecommunications technologies make possible access to a wide range of information resources."

  (Von Wahlde and Schiller 1993, 15)

- "A virtual machine in which a number of users may work simultaneously at terminals, and to each of them it seems as though they have sole use of a large and powerful computer, possibly larger than the real machine at the end of the cables leading from their terminals ... The library might be seen as a machine with many simultaneous users, each of whom perceives that he has the whole collection to himself, and further, through connections to other libraries ... access to much greater resources than are physically present."

  (Harley cited by Von Wahlde and Schiller 1993, 15)

- "Four basic potentials for the digital library are

  1. The digital library reduces constraints of time and place.

  2. The digital library supports the creation and use of *new more dynamic, integrated formats* for representing data, information, and knowledge.

  3. The digital library can support new forms of group collaboration in the creation and use of information; new communities of practice.

  4. The digital library enables customization and personalization of information, including assistance with management of information overload."

  (Atkins 1993, 2)

- " ... The electronic library will be realized as an aggregation of catalogs, lists, and indexes of documents of every imaginable type, organized according to myriad schemes of classification, and linked and cross-indexed for search, so that they come to behave as a single database in which the lines between individual collections and catalogs are blurred."

  (Nunberg 1993, 30)

3.2 Impetus

3.2.1 Putting a halt to building new facilities

- "[Libraries] will primarily be a series of small but powerful computers, linked to each other and the rest of the computers of the world. Where information is not available locally, the machines will automatically switch users to other remote computers. There will still be books in libraries and people reading them, but the collections will be more archival in nature. It is conceivable that a library could be only large enough to contain a bank of public terminals which will be used to retrieve and display information from remote databanks."

  (Corbin cited by Crismond 1986, 42)

- "Optical media warehousing and remote databases may halt the widespread emphasis on building large public libraries."

  (Olson cited by Hennen 1988, 391)

- "The rapidly rising prices of materials, the continued increase in the number of items available for purchase, the fact that university libraries seem to be acquiring a declining share of the world's output, the impracticality of continuing to build large, costly warehouse-type structures to shelve printed materials, thus replicating collections that exist elsewhere — these and other developments cause one to question whether established practices, which are already eroding, can be continued for very much longer."

  (Cummings et al. 1992)

- "*Libraries will not scale into the 21st century using the current model.* We cannot afford to provide new buildings to store information which is expanding at this exponential rate, much less acquire, under the current purchasing arrangements, the information itself."

  (Hawkins 1993, 7)

The impetus for digital libraries is the goal of putting a halt to the building of new facilities to house library acquisitions.

In the digital library future, physical space will be of little concern. Digital libraries make use of information technologies to store vast amounts of information in digital form. Digital library equipment requires a fraction of the amount of space given to storage of print collections and to staff required to maintain them. Furthermore, the physical location of digital libraries is not an issue because digital library collections will be accessible through information technologies making it possible for library staff and end users to access digital libraries from their offices, homes, or anywhere else at their convenience for their respective purposes.

Although buildings will be needed in the future to support new library functions (see section 10.8 for a discussion of these functions) and some existing ones, much less attention will be given to warehousing print-based collections and accommodating their users.

- "Space requirements for the digital storage of information when compared to print would be reduced by a factor of at least 1,000, and probably much more."

  (Seiler 1989, 16)

- "In the future, there should be less need for additional space as more information is stored in non-print formats. These alternative storage formats will result in more emphasis on equipment for access and on capitalization of necessary equipment."

  (Hoadley 1986, 23)

- "Perhaps not ten years from now but twenty-five or fifty years from now, a physical plant may not be needed to house the material being published at the time."

  (Anders, Cook, and Pitts 1992, 38)

- "As the current print collections are digitized and as they continue to rot on the shelves, the need for many buildings to house many collections will diminish. A few rare and historical volumes will be sent to museums. The rest will be recycled."

  (Seiler and Surprenant 1991, 30)

- "If for no other reason than to blunt this exponential increase in physical size, libraries will need to find a way to serve their patrons without being repositories for some significant segment of the world's information stock in the form of information artifacts. In the short term, this predictable increase in needed space will be handled by high density, probably off-site storage. In the longer term, it will be dealt with by sorting material in a digital, electronic format ... We will have print-on-demand production of artifacts.

  (Heterick 1990, 10)

- "We will still need library *buildings* during the period in which paper books are sliding into antiquity."

  (Kurzweil 1993, 55)

Raymond Kurzweil offers a caveat regarding the building of new libraries.

3.2.2 Reducing or controlling costs

- "Although we will see costs remain relatively constant, the number of research libraries, as we understand the term today, will likely be reduced."

  (Lynch 1993, 16)

- "The cost of scholarly journals is rising much faster than any other research cost."

  (Lyman 1991, 34)

  Also supporting: (Okerson 1986, 128–9)

- " ... Principal findings or observations of the Mellon study are:

1. Libraries have not taken a larger percentage of the university budget; their percentage has shrunk.

2. ... Expenditure on materials and binding continued to rise at the same time that the rate of volumes purchased actually declined.

3. Books (non-serials): in the 1970s and 1980s, the rate of increase in volumes added at university research libraries virtually halted, while domestic and international publishing continued to produce greater and greater numbers of new titles each year.

4. Serials: many speak of a 'serials crisis' at the heart of library difficulties today, and it is prices, and in particular science journal prices, that drive the crisis."

   (Cummings et al. 1992, xvii–xx)

A driving force behind digital libraries is the cost of scholarly information. For detailed information on costs, the authors recommend part one of *University libraries and scholarly communication* (Cummings et al. 1992), a study prepared for the Mellon Foundation.

- "The volume of scholarly information is increasing faster than the ability of researchers to manage it, publishers to print it, libraries to collect it, and scholars to read it. In some fields, the pace of research is so rapid that knowledge is time-sensitive. In a growing number of disciplines — and not just the sciences — knowledge is outdated by the time it appears in print. This shortened 'half-life' of information places greater emphasis upon informal modes of communication — the informal exchange of papers at scholarly meetings — or the formation of 'invisible colleges,' private information networks of affinity groups that exchange information, often by computer networks."

  (Lyman 1991, 34)

- " ... There is a tendency to concentrate on core materials, with the result that library collections are perhaps beginning to resemble one another more than before and lose some of the variety that previously distinguished them and some of the richness that characterized the entire national collection. To describe the significance of these developments in starkest form: as libraries are increasingly unable to respond effectively to increases in the numbers of book[s] published, the national collection is characterized by less comprehensive coverage of the world's title output, and access to information, the 'capital' of scholarship, may be said to be narrowing in this important respect."

  (Cummings et al. 1992, 76)

- "Trends (in higher education) that will most heavily influence a particular campus's preferred future become clear in the process of transforming visions into action-oriented plans. The unprioritized list compiled during workshop sessions included the following: developing the NREN, ... increasingly constrained budgets, proliferating information sources and spiraling costs of materials, pressing space and facilities maintenance needs, changing scholarly communication system, ... building relationships with the commercial sector, growing importance of government relations."

  (Dougherty and Hughes 1991, 10)

- "Although many faculty still prefer to find information by browsing in the stacks, library labor and infrastructure costs are soaring, and virtually the entire print collection is deteriorating because most of the knowledge published in the last century was on acidic paper."

  (Lyman 1991, 34)

- "Yet librarians have much in which they can take satisfaction. Their budgets have been keeping up with inflation. Not infrequently, they have grown faster than inflation ... The deeper reasons attributed to the librarians' inability to keep up their traditional level of coverage are familiar and bring no comfort. A sustained increase in the number of research papers published, due in part to researchers' need to publish to support their case for promotion and tenure; new journals launched in response to twigging in areas of scientific research; large price increases, due to the devaluation of the dollar compared to European currencies; none of these offers relief."

  (King 1990, 24)

Representing the publisher perspective, Timothy King attributes the inability of librarians to maintain high coverage levels to the information explosion, not to shrinking library budgets and acquisition costs.

3.2.3 Harnessing enabling technologies

The emergence of so many diverse groups involved in exploration of the digital library concept suggests that enough of the enabling technologies are now available and affordable to spark genuine interest in testing new forms of information capture, management and retrieval. This section features various technologies that are key to the development of digital libraries.

Interconnectivity:

- "The first barrier is connectivity ... Further, to support more than simple text, connectivity must be at a higher bandwidth than a modem and a dial phone offer. Beyond the achievement of simple connectivity is the acceptance and ubiquitous implementation of interchange standards and protocols. Even within a technically sophisticated and well-connected community such as the Internet, I find it incredible that basic, practical interchange standards for relatively simple structured textual documents (much less multimedia) essentially do not exist today — or at least they are not generally implemented."

(Lynch 1992b, 110)

Also supporting: (Kibby and Evans 1989, 15-16); (Woodsworth et al. 1989, 136); (Olsen 1990, 233); (Arms 1990b, 27); (Indiana University 1991, 21, 24); (Gapen cited by Saunders 1992b, 67); (Gapen 1993, 2); (Seiler and Surprenant 1991, 30, 152)

One key enabling technology is interconnectivity. It is the basis for much more powerful services that will enable end users to integrate access to information resources more conveniently into their everyday activities.

Powerful workstations:

- "There is a very clear common vision of the future: universal access, by students and faculty, to information in all possible media via a single, multifunction workstation. This vision is certainly shared by those leading the technology enterprises of our universities, as well as many faculty who see new and exciting methods of instruction, allowing students to integrate the knowledge of the ages."

  (Hawkins 1993, 4)

  Also supporting: (Nolte 1990, 17–20); (Bearman cited by Lynch 1991, 79–80); (LaRue 1993, 15, 16); (Kurzweil 1992c, 64); (Arms 1990a, 334); (Indiana University 1991, 21); (Young 1989, 9); (Dougherty and Hughes 1991, 11); (Dowlin 1991, 319)

Brian Hawkins' call for powerful workstations sums up many other writers' discussions on the need for such workstations to access digital library materials.

Caveats regarding powerful computers:

- "When you come in (to the public library), you might be issued a lap-top computer. You can take that lap-top anywhere in the building and connect it … and you are into the OPAC or whatever.

  (Dowlin 1991, 319)

- "Might it not be more forward thinking, even cheaper, to just give every household in the town a terminal? Why have a physical library when you can have a 'virtual library?'"

  (LaRue 1993, 15)

- Large and small cities and towns will have "the same incentive and political will to provide local library service to its citizens, which may very well include making notebook computers available themselves."

  (Kurzweil 1992c, 64)

Several writers recognize that the powerful computers required to access digital materials might not be available to the general citizenry, particularly public library users and make suggestions to remedy this.

James LaRue foresees access to digital library materials through cable service and the televisions that many citizens already own.

- "Not too far down the line, local library resources will be fully incorporated into your cable service. You'll have access to automated indexes, full text, and multimedia that the library has collected. Conceivably, you could see something on a TV show that baffles you and just zap over to the library channel to look it up. Then you could zap back."

  (LaRue 1993, 16)

New communication modes that cannot be represented on paper:

- "New technology-based forms of knowledge are emerging that cannot be represented or distributed by print media. These new forms range from information sources so vast they can only be managed by computer databases, to new modes of scientific visualization based on computer graphics, to new art forms such as computer music, to multimedia teaching environments."

  (Lyman 1991, 34)

Enabling technologies will engender new modes of communication that cannot be represented on paper. When such new modes are added to digital library collections, library users must have access to enabling technologies to fully experience these manifestations.

- "Structured information. This includes tagged-documents in, for example, SGML, but is meant to suggest a larger set of structures consisting of both content, as well as tags on the content, describing various attributes of the content. These attributes include formatting, designation of logical units in a document structure (e.g., chapter title), access control, links to related information, and so forth. The structuring information, especially if designed explicitly for machine processing, offers new potentials for enhancing precision and relevance of retrieval, facilitating human viewing and browsing, and inter- and intra-document linking. Structured information also provides a framework for creating integrated media documents including time-varying or continuous media much as audio and video … Compound documents have no full function, print-on-paper equivalent. These compound documents exist in full dynamic and interactive form, only in digital formats."

  (Atkins 1993, 3)

- Integrated media makes it possible to create "documents" that are changeable, interactive, non-linear, bear sound, color, video, and have no final beginnings, middles, and endings.

  (Lanham 1990, 38)

- "New technologies may ultimately spawn a new kind of discourse with fundamentally different features."

  (Cummings et al. 1992, 105)

- "But the computational representations of texts can be divided and reassembled in an indefinitely large number of documents, with the final form left to the decision of the individual user. To say that the reader 'writes' an electronic text is not simply a conceit of reception theory. This feature of the technology has figured prominently in the speculations of visionaries, who foresee a day when categories like 'literature' and 'knowledge' are freed from the trammels of narrativity and decomposed into a set of propositional atoms that readers can reassemble *ad libitem*."

  (Nunberg 1993, 22)

- "It is critical that in starting virtually 'from scratch' with a brand new 'making public' vehicle, we are unfettered by old modes of viewing and doing publishing: by existing notions of publishing offices; marginal cost structure of publishing; the idea of 'circulation;' indexing and abstracting; 'monographs' and 'serials;' advertising; ownership; possibly even profits. We have the opportunity to begin with a blank page — even that notion needs a new metaphor."

  (Okerson cited by Cummings et al. 1992, 127)

  Also supporting: (Young 1991, 12)

- "In addition to traditional text-based information, data accessible through the digital library system will include non-text information (photographs, drawings, illustrations, works of art); streams of numeric data (satellite information, cosmological data); digitized sound and moving visual images; multi-dimensional representations of forms or data (e.g., holograms); and the capacity to integrate these data into new representations drawn from many different sources."

  (Garrett 1993, 18)

- " ... The presentation of knowledge in static form, whether in print or as part of the emerging electronic library, is grossly inadequate. Scientists, often on their own and with inadequate support, are augmenting the passive presentation of knowledge by adding interactive, discipline-based knowledge bases that are developed, maintained, and shared across networks."

  (Lucier 1992, 26)

- " ... We can expect that completely new communication forms will emerge. Such capabilities would include the use of sound, moving pictures, and electronic analog modeling. These capabilities may well lead to new forms of art and imaginative literature."

  (Lancaster 1985, 555)

- "One clear advantage of electronic publications over print journals for scientists is they can add additional dimensions, such as depth or time, to the presentation of scientific data."

  (McDonald 1991, A6)

- Foster new types of scholarship: "integration of information as well as its retrieval, software can assist the user in locating information more easily, information can be integrated and connected to related concepts, and compound documents incorporating text, pictures, video, and sound can allow for multi-media environments that create new educational horizons. The recognition that the amount of information in our society is becoming overwhelming, and that we need new tools to navigate this information is not new ... This new information will include compound documents including images, data sets, graphics, and other multimedia materials, which have the potential of profoundly affecting the ways in which students are educated, and in which scholarship is shared."

  (Hawkins 1993, 7)

- The library will be "an active intelligent knowledge server. It stores knowledge of the disciplines in complex knowledge structures, perhaps in a knowledge representation formalism yet to be discovered or invented. It can reason with this knowledge to satisfy the needs of its users ... Authors may bypass text, adding their increment to human knowledge directly to knowledge structures."

  (Feigenbaum 1989, 122)

- "The ability to publish relatively raw experimental data and programs that model and manipulate, not merely summarize and analyze it ... "

  (Lynch 1993, 8)

- " ... Distributed network-based multimedia that combine images, sounds, text, computer programs, and other objects ... "

  (Lynch 1993, 8–9)

Other enabling technologies:

- Telefacsimile for document delivery.
- Online public access library catalogs that share a standard data format across libraries.
- Artificial intelligence.
- Graphic imaging technologies.
- Optical digital mass storage systems.
- Teleconferencing: person-to-person or group-to-group.
- Hypertext.
- Input technologies: OCR, voice processing, touch terminals, video/optical disks, holography.
- Output technologies: voice processing, flat panel displays.

Summing up the many enabling technology suggestions, Pat Molholt stresses the need for *"blending or integrating of multiple technologies to serve a single purpose."* Underlying her statement is the recognition that the goal of making digital library collections accessible to end users can only be achieved by integrating multiple enabling technologies.

- Processing technologies: robotics-expert systems, information retrieval.
- Transmission technologies: satellites, ISDNs and LANs.
- User interface software.
- Blending or integrating of multiple technologies to serve a single purpose.

Writers supporting one of more listed technologies:
(Arms 1990a, 337–9; 1990c, 32); (Dunstan 1986, 6); (DeBuse 1988, 9, 15, 16); (Olson cited by Hennen 1988, 391); (Eagle 1992, 100); (University of Alberta 1990, 12–13); (Molholt 1988, 44–5); (Murr and Williams 1987, 20–1); (Raitt 1985, 278–80); (Seiler 1989, 66); (Lynch 1993, 8); (Martyn 1991, 297)

Features of digital library artifacts:

Digital library artifacts have features that documents in print-based libraries do not have. They are available to users anytime and anywhere and are accessible to many users simultaneously.

- Available 24 hours a day, 7 days a week.

Supporting: (Hoadley 1986, 25); (Fisher 1988, 119); (Surprenant and Perry-Holmes 1985, 236); (Hacken 1988, 488); (Seiler and Surprenant 1991, 30); (Billings 1991a, 38); (Seiler 1992, 21)

- Available to users directly from their homes.

Supporting: (Vasilakis cited in Riggs and Sabine 1988, 3); (Wisener cited by Riggs and Sabine 1988, 25); (Young 1989, 9); (Moran 1989, 39)

- "Within ten years over half of the service provided to library users will be to individuals who never come into the library."

(Mason 1985, 137)

- Geographical ubiquity.

Supporting: (Buckland 1992, 43); (Kibby and Evans 1989, 20); (Butler 1991, 25); (Lyman 1991, 37); (Davis cited by Hacken 1988, 488); (Hacken 1988, 488); (Seiler 1989, 16)

- Several people can use the same database or electronic records at the same time.

  Supporting: (Buckland 1992, 43); (Butler 1991, 25); (Seiler 1989, 16)

- Authors may have virtually the entire recorded knowledge of their discipline immediately available to them through their workstation.

  Supporting: (DeBuse 1988, 15); (Martyn 1991, 297)

Loss, destruction, deterioration:

There are easy ways to safeguard digital libraries from loss, damage, or catastrophe.

- An electronic collection ... cannot be lost ... It can be exported to outside users as an offset against the investment in the collection.

  (Butler 1991, 25)

- "Electronic libraries, on the other hand, have the potential to overcome many of these shortcomings. When the full text of published matter is stored electronically, it need never deteriorate. Electronic copies can be made and then stored in distant locations to protect against day-to-day hazards, fires, or other calamities ...Vandalism caused by theft or tearing articles from journals would end, although the problems of computer viruses and the electronic alteration of materials are new and real concerns."

  (Seiler 1989, 16)

Interacting with digital library artifacts:

Users can interact with digital artifacts in entirely new ways. For example, they can acknowledge relationships between artifacts, create different manifestations of original artifacts, and capture artifact segments to include in new ones.

- " ... Electronic documents are easily copied ... Documents stored electronically are very flexible. They are easy to revise, rearrange, reformat, and combine with other documents ... Collections of documents stored in electronic form are now less bulky than paper versions. The trend is to even greater compactness."

  (Buckland 1992, 43)

- "Individuation. Technology allows us some simple pleasures of life — the ability to change our mind — to format a document one way and change it several times, print it in different fonts and type sizes, etc."

  (Molholt 1988, 46)

- Opportunity for hypertext links between documents, e.g., highlighting a reference and having the computer find and display the full text of the referenced article, soundtrack, dataset, etc.

  Supporting: (Seiler 1989, 66); (Lynch 1993, 8); (Martyn 1991, 297); (DeBuse 1988, 15)

- "We will want to interact within the structure of the publication — perhaps to cut and paste, to capture and search for a citation, to import and export content, to examine visual components of the publication, and so on. We would require that the system function with a high degree of autonomy so that it can fulfill our information needs and supply us with the content that conforms to our individual profile. We want a system to perform the management operations for publications — acquisition, intellectual property considerations, formatting, access, awareness, and as such, independently. The system must interoperate with other systems and support, enable, and provide linkages to other systems and other related information. We want the system to provide a high degree of personal freedom for the user. And we want to the system to be present with new information and to be on call and easily accessible for older publications."

  (Anderson 1993, 106)

Caveats to the advantages of digital library features:

- " ... More publications, print or electronic, do not necessarily equal more information. The 'publication explosion' often makes uncovering important information harder ... Many researchers attribute the surfeit of mediocre articles to pressures to gain tenure, status, promotion and grants, not to the uncovering of new information. More often than finding too few citations, librarians and end-users find far too many to process effectively ... Most would agree that what is needed is more information that is relevant, accurate, authoritative and scientifically reliable, not just 'more information.'"

  (King 1993, 167)

- "By integrity I refer to the preservation of information over time by a set of standards, as in maintaining the integrity of a journal article ... Electronic publication offers, for example, the potential for updating and correcting articles ... In addition to changes that authors desire, journals could attach statements to articles an editorial board determines to be in error, fraudulent, or in bad taste ... The question is — who will be allowed to exploit this potential and in what ways? It is possible that court cases involving national security; patent infringement; fraud ... ; slander could result in orders to delete or modify previously published information."

  (Seiler 1989, 67)

- "It appears that both the authors and the editorial board need predictable deadlines which provide a motivation for them to schedule a definite time within a week to finish their work ... In addition, at least some readers like the predictability of a new issue every Monday morning, waiting online."

  (Turoff and Hiltz cited by Piternick 1991, 22)

Several writers offer caveats to the advantages of digital library features. Some caveats are carryovers from print-based environments, for example, the problems of finding too much material and/or too much mediocre material. Other caveats are entirely new problems that are characteristic of digital environments, for example, the problem of data integrity.

- "Electronic access creates a new publishing problem: the possibility of publishing papers too quickly for the author to incorporate any second thoughts."

  (Oakeshott cited by Piternick 1991, 23)

- "Electronic journals will reduce the proliferation of superfluous publishing; *or* they will enable scholars to publish more, faster."

  (Langschied cited in "The impact of electronic journals" 1991, 185)

- Create more paper.

  (Alley 1991, 1)

In view of experience with today's digital documents, Brian Alley concludes that they create more paper.

3.2.4 Accepting the access paradigm shift

Over the years, librarians have amassed and warehoused large print-based collections to support inquiry, teaching, scholarship, and advanced research. In recent years, however, they have come to realize that they cannot continue to strive for comprehensiveness in collection building for many reasons — the increasing cost of library materials (especially journals), the sheer volume of scholarly information that increases faster than the ability of publishers to print it, institutions to pay for it, librarians to collect it, administrators to build structures to house it, and scholars to read it. At the same time, the availability and affordability of various enabling technologies may significantly reduce collection building efforts because librarians can rely on technologies to provide access to scholarly materials. In time, librarians have come to accept that as long as they can access the materials users desire when they desire them, they do not have to collect them. This shift in emphasis from acquisition to access has been characterized as the paradigm shift from ownership to access.

This section describes the access paradigm shift in terms of general and specific barriers to total and unqualified adoption of the notion of access over ownership.

Paradigm shift descriptions:

- "A library's holdings will be defined by access, not by possession. Much of the library's material will be delivered in electronic form, or printed on demand. There will be 'some inherently electronic objects that cannot be examined except through computer and networks,' (after Lynch 1991, 78) and when the library user accesses these electronic resources, the system will 'enforce intellectual property rights and, if appropriate, collect royalties' (after Lynch 1991, 78)."

  (Wegner 1992, 86)

  Also supporting: (De Gennaro 1989, 40); (Horny 1987, 8); (Lancaster 1985, 554); (Woodsworth and Hoffman 1988, 92); (Dougherty 1991, 59); (Sack 1986, 541); (Dougherty and Hughes 1993, 11); (White 1990, 54); (Wegner 1992, 87); (Lancaster 1983, 749); (Hawkins 1993, 7); (Von Wahlde and Schiller 1993, 32); (Spigai 1984, 8); (Newman cited by Breivik and Gee 1989, 139); (Young 1991, 7)

- "The new paradigm would see the library acquiring material to support the undergraduate curriculum, research at a basic level, and designated collections of strength. It would not however pretend to support all advanced research from its own collections. Institutional ownership and self-sufficiency at this margin will be replaced by inter-institutional cooperation and resource sharing."

  (University of Alberta 1990, 10)

Lucy Siefert Wegner's statement sums up the paradigm shift as a emphasis from acquisition to access. The paradigm shift is a key impetus for the digital library. If librarians fail to accept this paradigm shift, they will be stuck on continuing business as usual, that is, acquiring publications and warehousing them for some future unspecified purpose.

Wegner is not the only writer who advocates the paradigm shift. She has plenty of company.

- "Will the library warehouse books ten years from now? Library managers will continuously weigh the benefits of access over ownership. Ownership will prevail over access in the following circumstances: when a library has consciously chosen to serve as an archive; ... when it is cost-effective; ... when access is difficult in terms of technology or time ... Access will prevail ... when access is less expensive than purchasing, processing, shelving, and housing information; ... access is timely and simple; ... the only way to acquire the information is through electronic access or interlibrary loan; ... access 'enhances' information."

  (Anders, Cook, and Pitts 1992, 37)

- " ... Information is not important until a user needs it, and that its location prior to the user's need is of no consequence. What is important is convenient access to appropriate information when it is needed, the ability of the user to discriminate among a variety of sources to decide what is most pertinent, and the capability to transfer that information to the scholar for display and processing when it is needed, where it is needed."

  (Billings 1991b, 5)

- " ... The core of library service — dispersal of ideas — will have broken loose from the fetters of a physical building to roam the airwaves and optic-fiber byways leading to Everyman. This prospect seems to lead to an increasing emphasis in collection development on access rather than ownership."

  (Hacken 1988, 488)

Caveats or paradigm shift alternatives:

- " ... The creation and distribution of information in electronic forms is contributing to the shift in libraries from 'ownership' to 'access,' from 'landlord' to 'tenant,' if you will."

  (Lowry 1993, 61)

- "I think that we are, like it or not, entering a Golden Age of Cooperation because (1) the technology to link libraries and to make the users of one library aware of the collections of others is available and getting better all the time, and (2) economics are forcing us to cooperate."

  (Gorman 1991, 7)

A few writers are reluctant to embrace the access paradigm with total enthusiasm. Anita Lowry characterizes the unfortunate consequence of the paradigm shift as a *"landlord and tenant"* relationship between information provider and library. Michael Gorman feels that librarians are entering a *"golden age of cooperation"* in which technology will make cooperation between libraries of vital importance.

Economic barriers:

- "The promise of increased and faster access applies only to those institutions and individuals who are willing and able to pay for it. Electronic networks increase access only if those who want access can afford the necessary equipment, software, telecommunications and database charges, and possess the skill to use them."

  (King 1993, 167)

- "Economic forces will shape the future library more than either user needs or evolving information technology."

  (Eaton cited by Billings 1991b, 6)

- "Because monetary resources rather than technology are the restraining factor, most of the next decade will be spent in putting these pieces [i.e., electronic library resources] into full working order in the largest and most affluent libraries and in beginning to provide such services in less wealthy environments."

  (Martin 1989b, 399)

Economic factors could prevent libraries from making the paradigm shift. The library goal of universal access to information resources could be a chimera because of the many costs associated with digital libraries. That is, information technologies will be expensive to purchase, deploy, maintain, and keep current, and desirable information on the network will be expensive.

Generational shift barriers:

- "Younger researchers will lead the way until there is a critical mass of 'e-publications.' That is, no one will write for e-journals until they are a valued method of communication and they won't be valued until many people write for them."

  (Langschied cited by "The impact of electronic journals" 1991, 186)

- "A more serious barrier [to paperless libraries] is a psychological one. So far, computers seem not to have reduced the production of paper. Far from it. It appears that many people do not feel comfortable with records that exist only in electronic form. How long this dependence on paper will last remains to be seen. As it becomes easier and cheaper to store records in electronic form, through the medium of a personal computer, this situation may well change. Furthermore, a younger generation, growing up with a diet of computers and electronic games, may be less insistent on the need for paper copy."

  (Lancaster 1985, 555)

- "The other factor that we may have overlooked is a generational effect ... We are only now starting to build a critical mass of scholars who have 'grown up' with the new technologies. As the demographics of the scholarly community change, so may change the system of scholarly communication."

  (Lynch 1992b, 111)

- "Ten years from now, the adults will have grown up with computer games and computers in school labs. The entire environment and receptivity, and expectations, will have changed. We may remain the same, but our users will not."

  (Martin 1989a, 405)

Even with the right economics and technology, the paradigm shift may be a long time in the making because active scholars have neither the experience nor training to transform their ideas into digital artifacts, particularly those that utilize features that are not available in print technologies such as sound, video, and hypertext.

Several writers suggest a generational shift is also necessary to create a critical mass of individuals who are familiar with the technology and feel confident to express their ideas in it.

- "Perhaps a psychological change will come quickly and persons who grow up with microcomputers and online files will not hesitate to accept an electronic database as a definitive source of information without any need for a hardcopy record."

  (Horny 1992, 123)

- "Kids coming into the high schools today already know how to use computers. They have computers at home, they have VCRs at home, they know how to manipulate various kinds of equipment ... They're much more adept at using equipment than teachers are. They're not threatened by technology, they're challenged by it. Kids also will be much better able to communicate visually than they are today ... They are much more visual than adults and I see this increasing. It's another area in which we as adults need to improve our skills because they're really far ahead of us."

  (Whitney cited by Riggs and Sabine 1988, 20)

Technological barriers:

- "Building the National Information Infrastructure, and its constituent digital library system, is one of the pivotal challenges of this century. Many of the most difficult tasks are social and cultural, economic, and technical."

  (Garrett 1993, 18)

- "Campus computing telecommunications infrastructures need to be upgraded to make widespread use of the new technologies possible. Some of the upgrades are necessary in any event, but they carry real costs."

  (Cummings et al., xxvi)

Writers focus on network building as a crucial barrier to digital library development. Arnold Hirshon also comments on the maturity of information technology and the *"clumsiness"* of existing products to perform simple tasks. Without a doubt, the technology must become easier to enable the general public to welcome it into their homes for everyday use.

- "Librarians may be ahead of some of the users in perceiving the inevitability and desirability of electronic information. The technology is not yet fully mature. Much of the electronic information is clumsy, and little nontextual information is available that is inexpensive or available for rapid delivery. However, these current factors should be seen not as limitations, but rather as opportunities. We are being given a few previous years (and probably our last opportunity) to make the transition to master this new form of communication, to make it our own, and to present ourselves as the natural teachers and navigators."

  (Hirshon 1993a, 3)

Other than technological barriers:

- "The paradigm shift will not be abrupt. Change will be gradual and evolutionary, with movement occurring as technological, political, and financial circumstances permit."

  (University of Alberta 1990, 11)

- "Copyright and economic issues of fair payment of authors and publishers for intellectual property will be the stumbling blocks, not the technology."

  (Hennen 1988, 390)

Although writers cite technological barriers to digital library development, they acknowledge that other barriers — political, social, legal, cultural, economic barriers — that stand in the way of such development may be more important or more difficult to resolve than technological ones.

- "Digital libraries will soon be available in a number of domains. Yet technical and legal, as well as economic and political, issues will demand our attention for decades to come. Gradually, with advances from the research community and support from governments, tremendous amounts of useful and usable information will become available to millions of individuals over high speed networks that encircle the globe. We will witness upheavals in many professions and institutions, with changing roles for authors, publishers, bookstores, abstracting and indexing services, citation processors, libraries, educational institutions, and professional associations."

  (Fox and Lunin 1993, 443)

- " ... A paperless society is unlikely, because the information scientists' vision of their new technological order has not come to terms with economic, legal, governmental, and political implementation problems.

  (Green 1984, 20)

- " ... As much effort must be invested in the development of innovative social, political and economic linkages as is now invested in the development of electronic linkages."

  (King 1993, 165)

- "The chief problems, however, are not technical, but political. What is lacking at the moment is a broad consensus that this is the kind of technology infrastructure that would substantially enhance education, research, and America's position in the global economy."

  (Weber 1990, 80)

- "The greatest challenge facing library leaders in the next decade is not to implement new technology, it is to implement entrepreneurially oriented management structures and cultures in our ailing industrial-age libraries."

  (De Gennaro 1989, 41)

- "The major impediments to a rapid and revolutionary change in the library paradigm are cultural. This paradigm shift requires changes in legislation, public policy, and common law. It requires significant adjustments in the economic domain for both suppliers and consumers and in the global marketplace beyond our national borders."

  (Heterick 1990, 9)

- "Informational territoriality still runs strong (in libraries), and there is a natural academic impulse to desire — if not demand — control over one's own informational resources."

  (Rochell 1987, 45)

- "Not only do networks stretch our print-bound delineation of roles, they also expose the limits of our policies. The policy areas of concern to the emerging network include intellectual property law, social policy, and regulation of communications. Our social laws and customs result from an industrial era with different priorities and parameters than those common to the emerging knowledge network community."

  (Young 1991, 12)

4 Phases in the application of information technology to libraries

In the course of reviewing literature on the future of the library, the authors encountered several writers who identified phases in the application of information technology to libraries. It is interesting to review these statements to determine whether there is consensus about the phase libraries are currently in.

Modernization and transformation:

- "Modernization can be defined as the use of new technology to continue to do what you have been doing, but in a more efficient and/or cost-effective way. In the library context, one example is the use of computers to automate library processes of circulation and serials check-in. There are experiments currently underway (such as the Elsevier TULIP project) which address the modernization of journal publishing ... Transformation addresses the use of new technology to change processes in a fundamental way. A shift from a scholarly communication system that fixes results into print publications to one that relies on quality controlled distributed hypertext databases that are updated continuously, accessed and distributed through computer communications networks, and perhaps controlled by intelligent agent programs operating on behalf of end users, describes a potential transformation."

(Lynch 1993, 8)

Clifford Lynch distinguishes between the phases of *"modernization"* and *"transformation."* He notes that current digital library projects such as TULIP are still in the former phase. Librarians have yet to undertake "transformational" projects, that is, projects in which *"technology changes processes in a fundamental way."*

Paper, automated, and electronic libraries:

- (1) Paper library, (2) automated library: collections of library materials are primarily on paper but in which the library's *procedures* have been computerized, (3) electronic library: documents are stored in electronic form.

(Buckland 1992, 18, 42)

Michael Buckland identifies three phases. Today's digital library projects could be placed in his third stage in which *"documents are stored in electronic form."*

Traditional, modern, and future libraries:

- "When speaking about libraries and their history, it is possible to identify three main periods: the traditional library from Aristotle up to the beginning of library automation; the modern or automated library, where computers have been applied to basic services such as cataloguing and stock organisation; and finally the electronic library, the library of the future, where systems make information universally accessible online."

(Landoni , Catenazzi, and Gibb 1993, 175)

The three phases described by Monica Landoni, Nadia Catenazzi, and Forbes Gibb are comparable to Buckland's three phases.

Phases of library automation:

- " ... Two distinct phases of library automation ... Phase I centered around just a few things, primarily inventory control and rudimentary circulation functions. This period also saw — in the creation of the electronic card catalog — the beginning of our automated indexes to information ... Phase II of the computer revolution extended this computerized indexing. It was no longer sufficient to list library holdings. We needed electronic versions of the more useful reference titles ... But the most significant accomplishment of Phase II was the shift from 'electronic indexes,' to the storage and retrieval of the information itself. Now our periodical indexes needed summaries. Abstracts were better. Full text was best ... Libraries have begun to automate such local information as community information referral databases, online reference questions, community calendars, voter information, day care providers, and so on."

(LaRue 1993, 14)

Phases described by James LaRue could be covered by the *"modernization"* phase that Clifford Lynch describes.

Generations of computing:

- "In the library profession today, we speak of three generations of computing ... The first generation — which has essentially occupied us for the past fifteen years — has been the application of computer and communications technologies to library processing activities ... Enter the second generation. A number of commercial vendors have emerged from the first generation with software and hardware products to support the maintenance of integrated local systems ... We have begun the planning and development efforts for the Third Generation, which will move a set of software applications to the scholar's workstation, enabling the selective downloading and interactive manipulation of this wealth of information by individual users"

(Battin 1984, 3–4)

The three generations of computing in libraries described by Pat Battin are comparable to Lynch's *"modernization"* phase.

Procedural and substantive phases:

- "The procedural phase, already underway ... has focused on redefining the means libraries use to provide patrons with printed information ... [It] will be succeeded by a substantive phase in which the old technology of print will be replaced by a paperless world of the computer."

  (Green 1984, 15)

The distinction between the two phases William Green describes is the form of library materials: print-based and nonprint-based.

Miscellaneous comments on technology phases:

- "(1) You automate what you have been doing manually; (2) you find that what you do changes; and (3) society changes in response to these forces."

  (Diebold cited by Martin 1989a, 398)

- "I would argue that what we have achieved in our libraries to date is noting more than an *electronically assisted* library, not a virtual library."

  (LaRue 1993, 16)

- "The period of technology upheaval: 1960s—1980s; period of technology absorption: 1980–2000."

  (Davis 1987, 3)

- "Increased publication in hypermedia will accelerate the trend (toward electronic publication) for the simple reason that hypermedia can't be printed on paper and still retain its unique characteristics and advantages."

  (DeBuse 1988, 16)

- "When the primary artifact is itself electronic the real revolution will begin."

  ("What presidents need to know" 1993, 2)

Miscellaneous comments on information technology in libraries are given here. The last statement on the *"real revolution"* sums up what is needed to move libraries from Clifford Lynch's *"modernization"* to the *"transformation"* phase.

5 Print-based technology

This section reviews desirable and undesirable features of print-based technology. It also covers predictions regarding the demise of documents created by print-based technology and the rise of artifacts created by computer-based technology.

On one hand, one could argue that digital library artifacts will not become ubiquitous until they have the same desirable features as books. On the other hand, it may not be fair to require that digital library artifacts have the same features as print media because the former will have capabilities above and beyond the latter. It is useful, however, to review desirable and undesirable features of print-based technology to ensure that digital library designers focus on and overcome limitations associated with the latter.

5.1 Desirable features

- Portable.

  Supporting: (Drake 1990b, 168); (Eastman cited by Riggs and Sabine 1988, 19–20); (Drake 1988, 116); (Martyn 1991, 295); (Wegner 1992, 88); (Landoni, Catenazzi, and Gibb 1993, 178)

- Require no outside power source.

  (Wegner 1992, 88)

- Easy to browse.

  Supporting: (Drake 1990b, 168); (Drake 1988, 116); (Landoni, Catenazzi, and Gibb 1993, 178)

- Require no special training or knowledge to use.

  Supporting: (Wegner 1992, 88); (Landoni, Catenazzi, and Gibb 1993, 178)

- "People like books."

  (Gorman 1991, 6)

Here is a long list of desirable features of books and other print media. Some features specifically address print-based technology, e.g., portability, no outside power source requirement, resolution. Other features are connected with users and print-based technology, e.g., user training, browsing documents created by print-based technology, familiarity with print-based technology.

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- "The advantages of printed over electronic books as a medium of information storage and exchange are that they are robust, they need zero power, several can be open at once, they have been around for 550 years, all literate people know how to use them, and they are readable in strong sunlight."

  (Rawlins 1993, 475)

- Paper does not flicker. The flicker of the typical computer screen substantially slows down reading speeds (which is one reason that reading on a screen is less pleasant than reading a printed book).

  (Kurzweil 1992a, 82; 1992b, 140)

- A good quality book has an ink-to-paper contrast of about 120:1. Typical screens are half that. Yet technology is catching up with the Apple Powerbook 170 that has contrast ratio of 95:1 — close to paper's contrast ratio of 120:1.

  Supporting: (Kurzweil 1992a, 82; 1992b, 140); (Landoni, Catenazzi, and Gibb 1993, 178)

- Print and illustrations in a printed book have a resolution of about 600 to 1,000 dots per inch (dpi). Typical screens are one-tenth that with CD/ROM-based books providing even less. Yet technology is catching up and by the turn of century, resolution should range from 500 to 1,000 dpi.

  Supporting: (Kurzweil 1992a, 82; 1992b, 140)

- "There is the issue of *available software* ... the enormous installed base of print books ... 50,000 new print books published in the United States and millions of books in circulation."

  (Kurzweil 1992a, 82)

- Users can access printed works without hardware, add annotations and underline or highlight text. Printed works conform to certain design and typographic conventions; furthermore, print is a well-defined method of reproduction.

  (Landoni, Catenazzi, and Gibb 1993, 178)

5.2 Undesirable features

- " ... Books and journals sit on shelves waiting for us to use our intelligence to find them, to interpret them, and cause them finally to divulge their stored knowledge."

  (Feigenbaum 1989, 122)

- "Paper is best except ... (1) when documents are highly *volatile*, (2) when *manipulation* of the document is desired, (3) when *scanning* for names or for particular words or phrases in a lengthy document, (4) when light use of *remote material* is needed, (5) when rapid *communication* is desired, especially within a dispersed group that is not conveniently available at the same time and place."

  (Buckland 1992, 45)

- Local nature of paper documents, take up space, inflexible, separate the catalog from text, separate users from catalogs and documents, available only when libraries are open, may be unavailable if they are already in use, time-consuming for users to search large collections, difficulties of scale — especially large collections.

  (Buckland 1992, 10–15)

- "Their disadvantages are that illiterate people cannot use them, it is easier to print an electronic book than it is to digitize a printed book, and it is hard to collate nonsequential but related parts of one book, or many books by several subjects. Further, they do not talk, adapt to their readers, or have animated illustrations or music. They do not let readers zoom or pan illustrations, or increase or decrease their font size, nor do they recognize voice commands or visual cues. Finally, they are not cheap, long lasting, easily copied, quickly acquired, easily searched, or portable in bulk."

  (Rawlins 1993, 475)

Here is a long laundry list of undesirable features of books and other printed media. In view of the length of this list and the many minuses connected with print media, one could raise the question of why they remain a key means of communication. Section 3.2.4 of this report sheds some light on the answer to this question. That is, economic, legal, political, cultural, technological, and social factors are barriers to general acceptance and widespread adoption of digital artifacts as a key means of communication.

- "Difficult to reproduce, expensive to disseminate, difficult to update, single copies cannot easily be shared, easily damaged and vandalized, bulky to transport, embedded material is unreactive and static, cannot utilize sound, cannot utilize automation or moving pictures, unable to monitor reader's activity, cannot assess reader's understanding, unable to adapt material dynamically."

  (Barker 1992, 139)

- Engage only a single sense (vision for the sighted), linear, expensive, heavy, highly consuming of space, hard to reprint, subject to premature physical deterioration, limited hypertext capabilities, not interactive, modifying and updating is costly and time consuming.

  (Seiler 1992, 20)

- "Monographs take longer to get to publication than do periodicals. They are not easily transportable electronically ... are packaged to contain a substantial chunk of information. Yet studies show that individuals rarely use whole books; they use parts of books. So scholarly presses face the challenge of figuring out ways to provide discrete segments of books, repackaged to be relevant to users' needs."

  (Gherman 1991, A36)

- Limits on article length, lack of timeliness, do not allow an update trail to be attached to articles for comments, error correction, possibility of becoming easily damaged, cost of dissemination, difficulty of locating information; limited circulation.

  Supporting: (Barker 1992, 139); (Landoni, Catenazzi, and Gibb 1993, 178); (Smith 1992, 48)

5.3 First digital library artifacts

- By the end of this decade (1990s), Mr. Arms predicts, "all science and engineering publications will be available electronically. A first-class science and engineering library without paper will be possible then... Transferring from a paper to an electronic library is a 25-year project."

  (Arms cited by Watkins, 1992, A19)

- "It will presumably happen first in disciplines whose primary sources are already online. The computer science discipline ... physics and engineering ... largely because of the critical need for timeliness in some fields. The shift will also come earliest in those disciplines, such as education and librarianship, where electronic access is itself an object of study ... It will spread to some degree to most disciplines, no matter how 'paperless' a discipline may seem at the present moment."

  (Sack 1986, 542)

  Also supporting: ((Lynch 1991, 81)

- "The digital medium is so powerful that during the next century it will all but eradicate its competitors — analog, print, handwriting, hand drawing."

  (Seiler and Surprenant 1991, 29)

- "Except for a limited number of general circulation titles and perhaps those most heavily used in major disciplines, the journal as we know it will cease to exist and be replaced by electronic article access."

  (Horny 1987, 8)

- "Applications of the new digital technologies will come more rapidly to serials than to monographs."

  (Heterick 1990, 10)

- "Paper publication will decline in certain fields ... sci-tech and medical areas."

  (DeBuse 1988, 16)

Writers speculate that science materials — especially engineering, computer science, and physics — will be the first to be published as digital artifacts. Serials are also among the first candidates for digital production as are indexing and abstracting publications. Raymond DeBuse adds educational textbooks and how-to-books to this list. He is particularly keen on the development of interactive fiction and poetry by the turn of this century. Not all writers agree with him as they place fiction and poetry among the last forms of literature to become digital artifacts (section 5.4).

Of the writers contributing to this list, most would be optimistic that digital artifacts will become widely available by the turn of the century and commonplace by 2010.

- Electronic publishing has made it possible to create an electronic reference department — dictionaries, directories, almanacs, encyclopedias — especially in view of the need to update these works.

  (Jackson 1992, 311)

- "Before the year 2000, publishers of abstracting and indexing services, statistical compendia, directories, and other items containing numerical data or information for which currency is essential will have to adjust to an environment in which print is not the medium of choice."

  (Drake 1988, 117)

- Early adopters of the new medium will be developers of educational textbooks, writers of how-to books, and fiction writers. "Just wait, interactive fiction and poetry will become a major art form by the turn of the century."

  (DeBuse 1988, 15)

5.4 Last digital artifacts

- "Practically nobody would want to read a novel off the screen, or all in one sitting."

  (Martyn 1991, 295)

- "It is questionable whether *belle lettres* will be successful in electronic format. Because literature, unlike a directory or handbook, does not require updating ... There are advantages to publishing literature electronically, especially with the short time the contemporary literature remains in print."

  (Jackson 1992, 311)

- "Although scholarly information may migrate quickly to electronic form, popular novels and self-help books will persist in paper form indefinitely, and, thus, the economics of shared acquisitions and lending for this material will continue to be viable indefinitely."

  (Lynch 1992a, 32)

Writers speculate that contemplative works like fiction, poetry, and philosophy will be the longest surviving genres of literature to be published in print form. Until the technical limitations of today's computer screens are resolved, e.g., resolution, contrast (see section 5.1), users are unlikely to spend long periods of time reading text on computer screens.

Writers add coffee-table books to the list of long surviving genre. People probably appreciate such books for their workmanship, beauty, and entertainment value.

- "Tons of paper will continue to be consumed in pulp versions of Mazo del la Roche's *Jalna* or Louis L'Amour's *The Cherokee trail.*

  (Kountz 1992, 40)

- "Books intended to be read from cover to cover will survive. People are not likely to read poetry, drama, fiction, history, philosophy from a screen."

  (Drake 1990b, 168)

- " ... The personal computer does not mean an end to books — I think the printed word will be with us for a very long time. There are many kinds of communication that lend themselves to the printed page — reflective contemplative works, for example, or information that changes relatively infrequently and requires portability."

  (Battin 1984, 1)

- "The core of the library now, and in the year 2000, will be its book services. Our user public will continue to want to check out a book to read at their leisure at home or while traveling."

  (Crismond 1986, 44)

- "Coffee-table books ... will probably continue to be produced."

  (Martyn 1991, 297)

- "Just as the literary roll survived for centuries after the invention of the codex, literature may be the last survivor of the printed book."

  (Rubin 1990, 20)

For every genre of literature on this list, one could envision its digital counterpart. Imagine a digital version of James John Audobon's *Birds of America*. One could page through this digital coffee book's high quality color representations, listen to songs and calls, learn about different habitats and so on. *Birds* could pull double duty as a wall hanging. One could adjust the artifact to fill a particularly space on the wall. One could program *Birds* to display a different plate everyday or selected plates that match the decor of the room where it is displayed.

5.5 Coexistence of print documents and digital artifacts

Long-term survival of print documents:

- "I believe that the monograph as a form of publishing will always have a place because the need exists for the longer, contemplative, evolving piece of literature or scholarly thought that can be savored by readers at their leisure. There will also be a place for the publishers who produce these works; however, there will be fewer of them, and they will produce fewer monographs, and in smaller runs."

  (Gherman 1991, A36)

- "Paper will be with us for decades to come because of the hundreds of years of technological development behind simple, cheap, light, detectable pieces of paper, and the complementary use of hand and eye to arrange, read, or write them."

  (Rawlins 1993, 475–6)

- "It is unlikely that [electronic journals] will ever completely replace printed journals."

  (McDonald 1991, A6)

- " ... The enormous store of material in those old-fashioned but curiously convenient, random-access devices we call books and journals will neither go away nor become quickly obsolete. While we probably could, we surely won't use lasers to read the contents of every old book, journal, and newspaper — to say nothing of pamphlets, manuscripts, illustrations, charts, and graphs —into computer memories and storage devices."

  (Molholt 1986, 51)

Many writers believe that print documents will survive despite the availability of digital artifacts. A few qualify their beliefs by citing technological advantages of print documents such as simplicity, portability, and minimal requirements in terms of needed equipment to manipulate their contents.

- " ... I believe that print is likely to withstand the avalanche of competing media for quite some time — albeit circumscribed in application and diminished in importance. But growth in publishing — and, in some cases, survival — will lie in the ability to work creatively in multiple dimensions. The successful publisher will learn to provide an ever-changing variety of substance-process-format bundles."

  (Rubin 1990, 20)

- "Books will continue to be a prime recreational and informational tool."

  (Surprenant and Perry-Holmes 1985, 235)

- "I do not think that the printed word in the form of the codex will be supplanted entirely."

  (Stoker 1992, 184)

New and old technologies:

- "If the book is viewed as a technology and not as a particular physical form, it is clear that the book, or something like it, will always be used. The guiding principle is to use the appropriate technology for a particular purpose."

  (Wegner 1992, 88)

- "There will be printed books for the foreseeable future, but our problem will be the management of traditional and innovative information formats simultaneously."

  (Martin 1989b, 381)

- "It would be a mistake, however, to believe that electronic journals are going to replace present printed journals, anymore than television replaced motion pictures ... While a few new electronic journals have appeared, they are being created at the very margins of scholarship."

  (Billings 1991b, 3)

Writers whose statements are categorized in this subsection envision a future in which print documents and digital artifacts exist side by side.

As technologies mature and creators gain experience in producing new genres, we may see Lucy Siefert Wegner's statement ring true: *"The guiding principle is to use the appropriate technology for a particular purpose."*

- "New technologies do not always *abolish* previous technologies. People still go to concerts despite the advanced state of today's recording/playing; television has killed neither the radio nor the book. New technologies should be seen as doing what they always do — supplementing and enhancing old technologies. It is far better to see the world of knowledge and information technology as one that grows and enriches rather than one that dominates and destroys."

  (Gorman 1991, 6)

- "Books and computer output will coexist. Libraries will continue to add new technologies but these new technologies will not completely replace the existing ones."

  (Moran 1989, 39)

- "The traditional library elements exist with the new: sometimes being overlaid, sometimes existing side by side. Technologies don't simply become blended, as each serves its own purpose.'

  (Epstein 1991, 112)

- "Instead, what generally has happened during each new stage of communications technology is that the possibilities have expanded, not contracted."

  (Schuman 1990, 37)

- "The computer no more replaces the book than the Concorde replaces the Boeing 727 ... electronic technology simply creates an infinitely richer, more diverse information environment."

  (Galvin 1990, 2)

- "Color, sound, and even animation might work for a book on Picasso or on endangered wildlife, but it certainly wouldn't enhance a list of associations ... The electronic version of a book should not merely duplicate — and hence compete with — the print version ... Print and electronic technologies will coexist for years to come."

  (Hoffert 1992, 134)

- "The printed page will be with us for a long time because of its inherent advantages, just as people may still choose to walk, even when given the option to ride."

  (DeBuse 1988, 8)

Predictions involving dates:

- "A major technological change foreseen in the publishing field is the growth in multimedia publishing, in which text, graphics, photographs, sound and moving images will all be integrated. This will mostly be based on optical disk technology. Electronic books maybe widely available in the bookshops by 1995, if the price is right; but the printed book will still be with us for a long time to come. A slow trend towards electronic distribution of professional publications is envisaged."

  (Vickers 1991, 82)

Of the writers making predictions, Peter Vickers is the most optimistic about digital media, foreseeing widespread availability of such media by 1995. Daniel Atkins makes a strong case for digital artifacts in view of the production of most new information in digital formats.

- "Although print-on-paper medium will continue to be very important, especially as an interface medium to humans, we are already well into the digital information world. It is estimated that the nascent and master form for 90% of all new information is already digital formats: professional audio and video recording, computer-based document processing, and increasingly still images. The physical basis for information creation, preservation, and distribution is rapidly shifting from high-mass print on paper to very low-mass digital encoding represented by electronic, photon, and magnetic phenomena. These provide the opportunity to move information near the speed of light and to reuse it without using it up."

  (Atkins 1993, 2)

Although several writers make predictions about digital media in the 1990s and first decade of the new century, they still envision that much communication will remain in print formats. The most long-term view is offered by Charles Ritcheson who targets the shift in balance from print documents to digital artifacts occurring almost fifty years from now.

- I think the best way to describe our situation now — and at least the next ten years — is that of an intersection of two information systems, one print and one electronic."

  (Branin 1992, 322)

- "Undoubtedly, the collection format of the nation's libraries will remain basically as is during the 90's. Books and periodicals in paper copy will continue to be the primary carriers of knowledge. We will witness a conversion to electronic formats for periodicals; 15 to 20% of scientific periodicals may in electronic format by the mid 90's."

  (Riggs cited by Riggs and Sabine 1988, 189)

- The personal computer of the early 2000s will match and surpass the essential qualities of paper and ink. The book will enter obsolescence, although because of its long history and enormous installed base, it will linger for a couple of decades before reaching antiquity.

  (Kurzweil 1992b, 141)

- "I predict that in 2001 (and for years after) print will be an important and, in many cases, the dominant form of carrier of knowledge and information... I have a feeling that electronic journals may be the 'microforms' of the waning years of the century, and predict that their impact will rise from the invisible to the minuscule in the next five years and that they will still be a relatively unimportant factor in 2001 ... Using electronics to create 'personalized' *printed* serials from a central database might well be a fruitful endeavor."

  (Gorman 1991, 6–7)

- "If one assumed that the number of electronic journals would grow to 100 by 1995 and 1,000 by the year 2000, they will still account for only a small proportion of the estimated 7,000 to 15,000 scholarly journals in existence. This is not something ... that is going to inundate us anytime soon."

  (Dillon cited by McDonald 1991, A6)

- "Who would rather have 10,000 electronic texts than 10,000 cataloged and classified books? The ultimate irony is that most people, I imagine, who locate an electronic monograph of interest would want to print it out ... Without a major innovation in technology, electronic monographs will *not* be an important feature of libraries in 2001... The storage and retrieval of images in combined video/computer systems will make a significant contribution to storing, preserving, and disseminating knowledge."

  (Gorman 1991, 7)

- "In 2006, libraries will continue to hold substantial book-form collections, thanks not only to serious efforts at preservation and the impracticality of transforming all existing texts into such alternate formats as optical disk, but also to the likelihood that many standard monographic materials will continue to be published in the eminently convenient traditional book format. While shorter documents are likely to be maintained in electronic databases with on-demand printing of hard copy, more extensive texts may continue to appear in bound editions, at least, when a significant amount of reader interest is anticipated."

  (Horny 1987, 7)

- "Only to a very limited degree will computers be used for full text until late in the next decade. However, electronic publishing of heavily used materials, such as journals and major reference works, will come more rapidly than for the general collections, which tend to be much less heavily used than computer technology would economically support at this time."

  (Leighton and Weber 1989, 24)

- "By the year 2010, much information will either have been converted to or be produced directly in electronic form, but not all information, factual or otherwise. Consequently, some special libraries will be totally electronic or paperless, while others will be a mix of print on paper and electronic resources."

  (Fisher 1988, 118)

- "Most projects maintain that the print format will remain the major format in the university library for the next twenty years."

  (Metz 1990, 30)

- "At some point in the 21st century, let us say by 2040, the balance will tilt away from the book and toward electronically manipulated and provided information."

  (Ritcheson 1988, 22)

Survival of print documents for various reasons:

- " ... We must identify and collect information that will be of critical use in the event of a disaster. A core 'basic survival' collection must become a part of every library so that each locality will have a chance at survival. Access to it must be simple and cannot depend on electronic means. To do otherwise is to neglect our responsibilities as professionals and to be so pessimistic as to think that there could never be a recovery from a limited nuclear war."

  (Surprenant 1985, 682)

- "Until the vast majority of customers, both individual and institutional, have the technological capacity to receive electronically transmitted information, paper will continue to be the primary format for scholarly publishing."

  (Battin 1989, 377)

- "Newspapers and magazines are unlikely to be marketed to any extent by being downloadable from the library because of the problems presented by advertising ... Few people would be willing to call up and read the adverts if they had to pay for them on a unit basis."

  (Martyn 1991, 297)

- "Ownership will still exist and print-based materials will be necessary for many years to come. The global publishing community is not prepared to move into a totally electronic environment, and certain disciplines will not shift to electronic texts as quickly as others. The task of organizing and preserving paper-based resources will not quickly disappear."

  (Dougherty and Hughes 1991, 15)

Several writers give unique reasons why print documents will continue to survive. Writing in 1985 (before the demise of the Soviet Union), Thomas Surprenant expresses concern about a nuclear disaster that would threaten our ability to operate digital artifacts and calls for a *"basic survival"* collection of print documents. Others view the cost of technology, publisher readiness, and the viability of vast print-based collections as factors that will prevent the balance shifting toward production of digital artifacts in the near future.

- "The death knell of the book has been rung from time to time across my 30 years in publishing. Yet today more books are being sold and more people are reading more than ever in the history of this nation."

  (Eastman cited by Riggs and Sabine 1988, 27)

- " ... Books will not disappear or be transformed into electronic storage anytime in the near future due to the immense amount of data they make available, especially retrospectively."

  (Young 1989, 9)

5.6 Conversion of print collections

- "Eventually some kind of information appliance (computer) designed to facilitate the delivery and use of information will replace traditional library service for almost all subject disciplines. For those few subjects where the form of content and the economics of data conversion preclude full electronic support, modest traditional library service will continue."

  (Kountz 1992, 42)

- Unless collections are heavily accessed, no one will pay to put them into electronic format.

  (Richards cited by Watkins 1992, A20)

- "Classic materials for which a reasonable and long-lasting level of demand is predictable will ensure that their digitisation will soon follow. Other materials, for which some lower but not completely insignificant level of demand will continue to exist, will, if not digitised, ensure the survival of the library in its present conventional form for some time, until a cheap scanner for digitising text on demand becomes available."

  (Martyn 1991, 295)

The selections listed here suggest that high-use print documents will be among the first candidates for conversion.

Surprisingly few writers comment on the conversion of print collections to digital form. One reason for this oversight could be the enormity of the effort required to convert vast paper-based collections at the same time as digital libraries take shape. That is, it may be wise to tackle one daunting task at a time, first, the creation of digital libraries, and second, the conversion of print-based documents. Another reason could be the recognition that conversion to bit-mapped images is not that valuable. In the course of building digital libraries, a new information technology will probably emerge that will streamline the conversion process and transform paper-based collections into useful structures for computer manipulation.

6 Tools for accessing digital libraries

In print-based library collections, users call on their visual sense and physical capabilities to review library materials that they retrieve from bookshelves and to make intellectual connections between objects. Although they will still use the former sense to review digital library artifacts, they will have to rely on computer-based tools to access digital library collections because digital artifacts will not be physical objects. This section reviews access tools and techniques for digital libraries.

6.1 Ease of use

Here are selections that stress that the technology of the digital libraries should be transparent to users.

- "Ease of use — scholars should be able to use the library easily without having to become a computer programmer or librarian."

  (Kibby and Evans 1989, 20)

  Also supporting: (Olsen 1990, 235); (Dougherty and Hughes 1991, 10)

- "The malleability and geographical ubiquity of digital texts mean that end users will soon need the skills of information navigation now possessed only by librarians."

  (Lyman 1991, 37)

- "Technology will be transparent to the user, and, thus, less concern than the content of information access systems."

  (Woodsworth et al. 1989, 136)

- "Keyboards will be available along with mice, and it will be possible to direct computers by using touch-sensitive screens that accept handwriting or even by issuing voice commands."

  (Seiler and Surprenant 1991, 30)

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6.2 Browsing

- "In principle, the electronic library would have everything but the user still has to know what 'everything' is before asking for it. So there needs to be a mechanism like an OPAC allowing the user to find items by browsing and there also needs to be a mechanism for bringing items to the notice of users. One could imagine a system which would keep a record of users' previous requests and send notices of similar items recently received, when the user logged on to the system."

  (Martyn 1991, 297)

- "One difference that the virtual library presents is the loss of browsing physical items."

  (Saunders 1992a, 52)

- "One would hope that there would be some mechanisms for permitting serendipity, perhaps on the lines of a 'noisy' system which from time to time would send you materials at random, or would occasionally send you the wrong material in response to a request."

  (Martyn 1991, 297)

  Also supporting: (Nunberg 1993, 25)

Digital libraries should support browsing, a feature users find especially desirable in paper-based catalogs. To take advantage of the digital form of digital artifacts, browsing of digital libraries should extend to browsing of digital artifacts themselves. John Martyn suggests an interesting approach to digital library browsing in which the system would occasionally send *"you materials at random, or would occasionally send you the wrong material in response to a request."*

6.3 Standards

Calls for:

- "Underlying all of these efforts is the need to develop a common framework of standards, infrastructure, and access and distribution tools to facilitate electronic publishing and electronic scholarly communication. Print is a very effective standard. It can be shipped anywhere, and everyone can read it. There are few closed communities for the printed word, unlike those closed communities defined by computer network connectivity on various networks or the users of various types of computers."

  (Lynch 1992b, 110)

Standards are needed to facilitate electronic publishing and electronic scholarly communication. Standards would make it possible for individuals and groups to exchange digital artifacts regardless of the platform on which their ideas were created or the nature of their message — text, foreign characters, color, video, scientific notation, statistical data, sound, stills.

- "That great system is called *literature*. We don't think of it as a system, any more than the fish thinks of the water as a system, but it is. Literature is a system whereby *millions of ideas run on compatible equipment*. Three pieces of compatible equipment are called *desks*, *shelves*, and *minds*. We can put a book, a magazine, and a pamphlet that someone has preserved from the seventeenth century all on the same desk and compare them, and lo! They are all running on the same equipment without installation. A deeper aspect of this system is that it is very well *debugged*. What it allows is the intercomparison, commingling, and working together of all the ideas and points of view that have been placed for our use on these pieces of paper."

  (Nelson 1993, 12)

- "Substantial technical problems involve heterogeneity of access, retrieval protocols, and digital representation of information. The National Information Standards Organization (NISO), the organization that created the International Standard Book Number (ISBN), has sought, first, to recast bibliographic records so that their elements are appropriate to the distinctive features of electronic products. Standardization must extend eventually to the primary information itself, which is currently formatted in a bewildering variety of ways related to user interfaces, software packages, and system conventions."

  ("What presidents need to know" 1993, 3)

Standards would facilitate the transmission of artifacts between their creators and interested users and make it possible for users to incorporate their own ideas, attach a message or critique, and, possibly, communicate them to the original artifact creator(s) and/or others. The deployment of computer-based network agents would be expedited with the establishment of a host of standards. For example, artifacts could announce themselves to computer-based network agents that scour the network for material on particular topics of interest and bring them to the attention of the readers who profile and dispatch the agents.

Needed standards:

- Standards for document representation and exchange, e.g., SGML (Standard Generalized Markup Language), GES (Graphic Exchange Specification), ODA (Office Document Architecture).

  Supporting: (Kibby and Evans 1989, 16); (Arms 1990a, 347–9); (Blixrud 1993, 50); (Weber 1990, 78); (Butler 1992, 104); (Anderson 1993, 88)

- Peer-to-peer networking protocols, e.g., TCP/IP, OSI.

  Supporting: (Kibby and Evans 1989, 17); (Arms 1990b, 29); (Blixrud 1993, 53); (Weber 1990, 78, 79)

- Standards for images and storing text as images.

  Supporting: (Arms 1990a, 345-6); (Weber 1990, 78); (Blixrud 1993, 51)

- Information retrieval standards, e.g., Z39.50, structured query language (SQL).

  Supporting: (Kibby and Evans 1989, 17); (Blair 1992, 75); (Blixrud 1993, 53); (Lynch 1989, 24); (Atkins 1993, 2); (Cummings et al. 1992, 151)

- Display interface standards, e.g., XWindows, PostScript.

  Supporting: (Kibby and Evans 1989, 17); (Weber 1990, 78, 79)

- Data identification standards, e.g., ISBD, AACR, Universal Document Identifier (UDI).

  (Blixrud 1993, 50)

- Standards for data transfer, distribution, production, e.g., ASCII for text, UNIMARC for bibliographic record transfer, TIFF for image transfer.

  (Blixrud 1993, 51)

- Data integrity, i.e., standards needed for encryption, redundancy, system integrity.

  (Blixrud 1993, 51–2)

The specific standards given in this list will help to make the first generation of digital libraries possible. Standards will continue to evolve as will the technologies underlying digital libraries. Thus, future generations of digital libraries will go beyond the specific standards listed here.

The challenge here is doing something in order to create a standard or at least provide experience in terms of what standards are needed versus doing nothing because there is no standard.

- Operating systems.

  (Blixrud 1993, 52)

- User interface standards, e.g., graphical user interfaces, icons, light pens, touch screens.

  (Blixrud 1993, 52)

- Standards for discovering and navigating network resources, e.g., Archie, Gopher, World Wide Web (WWW), Hytelnet, Mosaic.

  (Blixrud 1993, 54)

- Standards for tracking network navigation and artifact usage; for accounting, billing, and charging users for artifact usage.

  (Blixrud 1993, 55)

- Standards for archiving or preserving network resources.

  (Blixrud 1993, 55)

- Standards for making bibliographic citations of digital artifacts.

  Supporting: (Anderson 1993, 88); (Alley 1991 1); (Piternick 1991, 25)

6.4 Index or guide to digital resources

- "What is necessary is the creation on the Internet of a publicly available union index of electronic documents generally available through electronic delivery channels."

  (Butler 1992, 104)

  Also supporting: (Yavarkovsky 1990, 17); (Lynch 1989, 25)

Several writers call for the creation of a network resource directory. Lawrence Murr and James Williams include such a directory in their long list of information tools for the digital library environment.

- "An organized means of locating information on the network is needed, as is an effective means of evaluating the usefulness of resources on the network ... A truly useful Internet resources guide should be accessible and searchable online, like a library catalog ... This is not so much a technical challenge as a challenge to make it a priority and to allocate the necessary resources."

  (Larsen 1990, 35)

- A specialized library will have unique opportunities to acquire, develop, and employ new information tools, such as: discipline-specific "expert systems," optical publications for instruction and continuing education (with sound, color, simulation, and animation), digital resources for specialized and/or general audiences and applications, portable optical-based libraries for specialists, video publications for briefing and training new employees, knowledge processing software tools.

  (Murr and Williams 1987, 23)

6.5 Future electronic readers

Portable computers:

- "The basic, stripped-down dynabook ... will allow one to read, view, and otherwise interact with hypermedia. Other versions will permit one to create new linkages of one's own choosing, personalize the publication, or relate it to other publications. Such devices may also let one annotate the work, insert electronic bookmarks, and, in the most complete version, create new hypertext publications. Of course there will be add-ons: a high-speed modem, additional optical memory drivers or readers, a digital TV module ... Wouldn't you really love to have a book you could read at the beach without the wind flipping pages? And that would allow you to look in on the afternoon baseball game every now and then?"

  (DeBuse 1988, 16)

At the present time, people will not spend long hours with digital artifacts because of the technical limitations and size of today's computers. Of the writers speculating on future portable computers, Raymond Kurzweil predicts that an electronic device comparable to the book may be available by the turn of the century.

- "Portable computers will evolve to papersize devices that exhibit both text and images — a Readman."

  (Seiler and Surprenant 1991, 30)

- "Small, portable device intended for general readers that can display the text and full-color illustrations of books records on Smartcards (cards about the size of a credit card with embedded memory chips)."

  (Malinconico 1992, 38)

- "Today's paperback novel reader may, before the year 2000, insert a credit-card-size piece of plastic into a high-resolution, flat-screen holder the size of a mass-market paperback, select the size, face, and color of the type she wishes to read, and push buttons to turn the pages, or have the pages turned automatically at her own reading pace. It is conceivable that she may dispense with text altogether, electing instead to view pictures while listening as the words are read aloud."

  (Rubin 1990, 19)

- "Virtual books will undoubtedly take many forms, but we can envision the basic model as a thin light slab with sizes ranging from pocket-sized to the full surface of one's desk. Resolution, color, contrast ratio, and lack of flicker will all match high-quality paper documents. These truly personal computers will be able to send and receive virtual books instantly through wireless communication."

  (Kurzweil 1993, 54)

- "The e-book, a small, hand-held, flat recording device able to replay text as a portable cassette player replays sound … You *can* cuddle up with an e-book."

  (Olson cited by Hennen 1988, 391)

- "Books and other texts will be read on inexpensive, hand-held flat-panel computers with photographic quality displays reproduced nearby on color printers with features of similar quality. Other technologies will permit cross-referencing of related images or texts and searching for pertinent information in several databases that could be widely dispersed geographically."

  (Weber 1990, 76)

- "Let us jump ahead and describe the notebook computer we are likely to see by the turn of the century based on readily discernible trends. Resolution will range from 500 to 1,000 dpi, the same as high-quality printed documents. The displays will be flicker free and will have contrast ratios and color capabilities comparable to paper and ink. The devices will come in a variety of sizes ranging from pocket-sized to double-hinged displays that will present two large pages. These computers will be thin (perhaps $^1/_2$"deep) and lightweight. By the end of this decade, the standard RAM chip will be one gigabyte (one billion bits), so the typical notebook will provide at least a billion bytes of random access memory. Low-bandwidth communication (text, voice, still pictures will be by wireless cellular transmission. High-bandwidth communication (moving high-resolution pictures) will be by optical fiber."

  (Kurzweil 1992b, 140)

- "Text materials would be delivered to a smart card or whatever storage device was used with an electronic book reader."

  (Martyn 1991, 295)

Ubiquitous computers:

- Displays will be flat 2 x 3 foot rectangles that hang on the wall and parade high-resolution images.

  Supporting: (Seiler and Surprenant 1991, 30); (Seiler 1992, 21)

We can expect a future in which computers are ubiquitous. They help us accomplish tasks and talk to one another to exchange information and build our personal knowledge databases.

- "This machine, not always in portable form, will be widespread in the home, car, and office. Most people will have several, although none may be called computers ... We will know that the machines are there."

  (DeBuse 1988, 7)

6.6 New organization and navigation techniques

Filtering techniques:

- With increasingly vast amounts of data at users' fingertips, digital libraries will need the tools to filter the data.

  Supporting: (Blair 1992, 72); (Mitchell and Saunders 1991, 10)

Filtering techniques will become an important tool to help users target desired information in increasingly vast digital libraries.

Knowbots:

- " ... *Knowbots* ... are active intelligent programs capable of exchanging messages with each other and moving from one system to another in carrying out the wishes of the user."

  (Kahn and Cerf 1988, 26)

  Also supporting: (Molholt 1988, 47); (Kurzweil 1992b, 141); (Lynch 1989, 25); (Sack 1986, 537); (Lynch 1993, 8); (Olson cited by Hennen 1988, 391); (DeBuse 1988, 16)

Robert Kahn and Vinton Cerf invented the notion of knowbots — a means of navigating complex systems. This notion has captured the imagination of several writers. Pat Molholt likens knowbots to traditional librarians who *"mediate between users and complex information systems; know the users' preferences, quirks, and interests; match needs to resources."*

- "At the Corporation for National Research Initiatives (CNRI), we have developed Knowbot® programs. These intelligent software agents can carry user instructions to many distributed digital libraries, as well as collect and filter data for relevance and importance."

  (Garrett 1993, 18)

  Also supporting: (Garrett and Lyons 1993, 469)

- "I fear some of these technologies are a bit beyond today's state-of-the-art, but ultimately we may see advanced networked-based software agents as Kahn's vision becomes reality."

  (Lynch 1992b, 108)

Knowbots not only search for information, they also perform tasks connected with tracking network navigation, artifact usage, billing, and so on. John Garrett mentions experiments with knowbots at CNRI. Although Clifford Lynch views knowbots as *"a bit beyond today's state-of-the-art,"* he recognizes that knowbots or a concept comparable to knowbots are very much needed in future information systems.

6.7 Bibliographic control

- "Increase efficiency of getting at information through better cataloging and organization."

  (Dougherty and Hughes 1993, 12)

- "Groups on campus that don't normally talk to each other — the fossil people and the art people — have to get together and try to see what their collections have in common ... The process of developing indexing, classification, and searching techniques for such diverse collections will possibly provide improved ways of approaching the search for information."

  (Saunders 1992a, 53)

- " ... Subject access will be improved by further rationalization of the structure of *Library of Congress Subject Headings* and the provision of additional access terms to machine-readable records. Methods will be developed to link special schemes, such as MeSH, with LCSH by sophisticated mapping of the relationships among these subject heading lists."

  (Horny 1987, 7–8)

Bibliographic control is truly an area that needs serious rethinking. In a digital library environment where digital artifacts such as books, journal articles, and yet-to-be-invented formats coexist, librarians must go beyond generalized tools such as subject headings and classification to streamline access to the world of networked information. Carol Mandel and Harold Billings suggest starting with the digital artifacts themselves. Then digital artifacts could be enjoined with other tools — knowbots, network resource directories, hypertext, filtering techniques, and so on — to establish intellectual connections between artifacts and organize networked information into logical structures.

- "What are we to do with a document in electronic form? There is little choice but to do the same as we do with a paper document or with a microfilm document: (1) catalog it and, as with manuscripts, pay careful attention to which version or state of text it is, (2) store it in some accessible place, (3) give it a call number, (4) ensure that pertinent bibliographic and location data are accessible in or through bibliographic databases."

  (Buckland 1992, 46)

- "Given increasing reliance on documents in machine-readable form, indexing and abstracting services are likely to assume every greater importance. Online access to such services is certain to be made available directly to users of a particular library's computer-based catalog, with some kind of standardized user-friendly interface."

  (Horny 1987, 8)

- "The finding tool can be merged with the material itself."

  (Mandel cited by Billings 1993, 34)

- "The information object will be its own catalog entry, identifier, and mechanism for delivery."

  (Billings 1993, 34)

- "The cataloger librarian will disappear, replaced by collection access enhancers."

  (Alley 1990, 577)

7 Digital library models

This section covers the various digital library models that writers have espoused. Some models such as the noncommercial publishing model and acquisition-on-demand model have been discussed at length in the literature. Thus, in this report, descriptions of these models are given first followed by additional explanation, rationale, and caveats. Since other models have received scant coverage in the professional literature, coverage of these models varies in this report.

The discussion of digital library models in section 7 strives to be objective. The authors revisit these models in the synthesis section of this report (section 12). While painting their own picture of the library of the future in the synthesis section, the authors make a case for preferring certain models over others.

7.1 Noncommercial publishing model

Description:

- "Model university policy: (a) initial publication of peer-reviewed and edited research results would be in journals supported by universities, scholarly associations, or other organizations sharing the mission to promote widespread, reasonable-cost access to research information; (b) electronic publication via the publicly supported portion of the worldwide Internet would be the preferred means for most disciplines; (c) research libraries would remain the primary access nodes and archival repositories for print and electronic collections of published research results; (d) some publishers would be licensed by individual researchers, university presses, and scholarly associations primarily to publish special compilations, indexes, or other value-added products for sale where potentially profitable markets exist for these secondary, value-added information resources, (e) the technical systems and scholarly communication policies needed to support this new scholarly communication systems would grow out of consensus deliberations and collaboration among associations of research libraries, research universities and their publishing arms, and societies or associations of researchers in the various scientific and technical disciplines."

  (Triangle Research Libraries Network 1993, v)

- "CNI's Working Group on Noncommercial Publishing has been actively investigating the potential for research organizations to establish an entire system of publication for materials emanating from our universities that bypasses private sector publishers entirely. Their rallying cry is, 'We created it in the first place; why should we give it away and then buy it back in the form of exorbitantly expensive journal subscriptions?'"

  (Neilsen 1991, 97)

Several names have been given to the noncommercial publishing model: model university policy, take it back model, circle of gifts concept, subsidized model. This model leaves out private-sector publishers entirely. Universities, libraries, university presses, societies, professional organizations, and other non-commercial agencies assume the role of publishers. The network performs dissemination tasks with the assistance of network navigation and access tools.

- "The distinguishing characteristics of the 'circle of gifts' concept are ownership and mission: the information published is owned by the scholars, learned societies, colleges, universities, and research institutions who have funded and created it. In charging it most closely resembles today's library circulation and interlibrary loan systems, which are subsidized or free to immediate 'members'; charged for cost recovery to the extended scholarly community; and sold at cost plus to for-profit purchasers."

  (Okerson 1992, 93)

- Subsidized model: electronic publications are posted to USENET are available by anonymous ftp. University departments are subsidizing publication.

  (Franks 1993, 9–10)

- "Widespread suggestions have been made for the establishment of publishing or information distribution mechanisms in not-for-profit agencies as replacements for commercial sector publishing."

  (Billings 1991a, 42)

Explanations:

- "Governance of the online publishing network would rest with the participating universities in the same way that university presses are managed. But each campus publishing or editorial node should be loosely related to editorial nodes on other campuses through an administrative structure resembling television broadcasting network affiliations … The result would be a network of autonomous units publishing original research and independently or jointly contracting for commercial and association publications."

  (Yavarkovsky 1990, 15–16)

This section gives additional explanations on how the noncommercial publishing model could be established. Clearly, unqualified support and approval for such a model would have to come from the highest levels of university administration across a broad sector of public and private institutions.

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- "Libraries and the scholarly community should cooperate to develop unbundled journals, establishing systems for review, sponsorship, and imprimatur by learned societies of articles published electronically and distributed at the quick of completion."

  (Billings 1993, 35)

- With respect to the medium-term evolution of university research libraries, faculty should "play a more active role in scholarly communication; take over publishing function; scan texts; distribute electronic texts; play a more direct role in communicating through discipline-oriented invisible colleges."

  (Faculty perspective cited by Dougherty and Hughes 1993, 11)

- With respect to the medium-term evolution of university research libraries, university administrators should support efforts to transform the university into "an information center; serve all kinds of clients; establish own organization to sell scholarly output; stimulate collaboration between providers and scholars."

  (University administrator perspective cited by Dougherty and Hughes 1993, 12)

- "The most fundamental change that must occur is a change in the manner in which rights are given to publishers for the academic information which is generated within the higher education community ... Alternatives to current copyright management can be imagined. For example, universities could claim joint ownership of scholarly writings with the faculty they pay to produce them, then prohibit unconditional assignment to third parties, thus becoming important players in the publishing business themselves."

  (Hawkins 1993, 19)

- Scholars in all disciplines could "publish" on the Scholarly Communication System. Readers could attach notes and usage would be logged. After six months, articles would be submitted to a review board that would place articles in categories, e.g., original contribution, extension of research, seriously flawed, no scholarly contribution. Royalty payments would be provided to authors whose articles were printed off.

  (Rogers and Hurt 1989, A5(·)

- "The economics of electronic publishing also makes it easier for individuals and organizations to take control of the publication process and cut traditional publishers out of the loop, so that jobs of editor and publishers coalesce. Institutions like libraries or research projects now can assume the publisher's roles. The multinational Human Genome Project has established an extensive internal system for publication and information management … The American Physical Society has proposed establishing a worldwide physics information system … There's the electronic samizdat of Internet and the other net services …"

  (Nunberg 1993, 20)

- " … University-based publishing is receiving significant attention as well as tremendous re-vitalization from the university-linked networks. The confluence of a number of factors suggests that the time is perfect for academe to re-affirm its commitment to wide distribution of scholarly information. The mechanisms are almost in place; the community is energetic and eager; the need is urgent. Many issues remain to be resolved, but it is the right time to attempt an old solution to this new problem: the unaffordability and diminished access to the 'body of knowledge.' The old solution is academe's vital participation as a publisher of its own research results."

  (Okerson 1991, 112)

Rationale:

- "Universities are the generators of scholarly information; universities are the consumers of scholarly information; therefore, universities should exploit the distribution and communication power of the network to distribute and manage their own information."

  (Anderson 1993, 102)

- "A university publishing network would facilitate and speed access to research results. It would bring order to the now informal and inexorably growing online publication process taking place through the Internet."

  (Yavarkovsky cited by Anderson 1993, 103)

- " ... The task force believes a first step toward controlling the spiraling costs of scientific and technical journals is to bring the products produced (the articles) back under the control of the producers (the research scholars and their universities) ... Returning ownership and control of research results to the individuals and institutions who generate them in the first place is a critical first step in moving towards a future where research results are peer reviewed and then disseminated electronically to the worldwide scholarly community at reasonable costs."

  (Triangle Research Libraries Network 1993, iv)

- "Academic institutions have played a significant role in the creation and distribution of knowledge ... The library could play a major role in the publication of working papers, which, when judged by the authors to be in acceptable form for general distribution, would be mounted on the library's computer, and with the proper indexing, be made available over telecommunication networks to other scholars and students ... The library's role will become critical to the distribution of knowledge: it will permit general access to new information faster than is now possible."

  (Wall 1986, 38)

The impetus for adoption of the noncommercial publishing model is the high cost of acquiring scholarly information from publishers. Greg Anderson sums up the most common rationale for this model: universities generate scholarly information, they consume it, and, thus, they should *"exploit the distribution and communication power of the network to distribute and manage their own information."*

- "The advent of electronic capabilities provides the university with the potential for becoming the primary publisher in the scholarly communication process. At the present time, we are in the untenable position of generating knowledge, giving it away to the commercial publisher, then buying it back for our scholars at increasingly prohibitive prices ... The electronic revolution provides the potential for developing university controlled publishing enterprises through scholarly networks supported either by individual institutions or consortia."

  (Battin 1983/84, 30)

- "I think making scholarly information freely accessible to the individual scholar gratis makes for the best scholarship for all of humanity. But even if we do elect to make individual scholars pay for access to one another's work, let us make sure that we do not add on spurious surcharges that are merely holdovers from the obsolete papyrocentric model."

  (Harnad 1992, 61)

- "We can have our cake — and eat it, too — if we sell it."

  (Line cited by Schuman 1990, 38)

Caveats:

- " ... Universities as the employers of the producers of much of the contents of the scholarly communications system, might assert ownership over the publications of their faculty. This may be a bad idea, and it may not be implementable, but it would certainly change the system in some major ways."

  (Lynch 1992b, 110)

Clifford Lynch is rather outspoken in his opposition to the noncommercial publishing model. He questions whether this model could be put in place in view of the legal challenges that would ensue.

- "Libraries have sometimes proposed breaking the economic grip of the publishers of scholarly information with the extreme remedy of 'taking back the means of production' — by altering institutional policies in higher education to encourage or require the institutions to retain copyright to faculty publications rather than having the faculty transfer the copyrights to publishers as a condition of publication. While this would probably make a major impact on the economic bind facing libraries, it seems unlikely that such a shift could be accomplished. Faculty would besiege university administrations, and publishers (and others) would challenge such policies in the courts and the legislatures."

  (Lynch 1993, 15)

  Also supporting: (Lynch 1989, 26)

7.2 Variations of the noncommercial publishing model

- Vanity press model would feature articles freely available on the Internet. The model does not support functions of certification, archiving, marketing that publishers perform quite well. The main advantage of the model is speed. "If only to meet the need of preprint distribution, the vanity press model of electronic publishing will be with us for the foreseeable future, and its use is likely to expand greatly."

  (Franks 1993, 4)

- On-line preprint exchange: papers would be maintained online for six months and then purged unless refereed and preserved in an archival record according to scholarly standards.

  Supporting: (Battin 1984, 6); (Rochell 1987, 45)

Both vanity press and preprint models do not include commercial publishers. Articles would be freely available to interested readers through the information network. Unlike the vanity press model, the preprint exchange would include article refereeing.

- "Many authors and researchers receive no money for the articles and chapters they write, while at the same time they feel abused by the process of trying to get their work published. What is to stop them from submitting their work to libraries directly? Authors could even go one step better than current practice and obtain their own reviewers, whom they would list, thereby letting us know exactly who certifies the piece ... There is a great potential here for authors to assume the responsibilities of those who have independently certified the rigor of information, or at least to simply sidestep the review process ... In the future, the mix of information with respect to rigor might change and leave a new level of confusion, much to the detriment of the reputation of libraries."

  (Seiler and Surprenant 1991, 31)

7.3 Acquisition-on-demand model

Description:

Generally, the acquisition-on-demand model is a transformation of the current system of scholarly publication. Authors will still submit their creations to publishers for acceptance and assistance in editing and dissemination. Publishers will still fulfill the dissemination role but they will utilize the communications network and, most likely, exact payment for various levels of artifact usage. In this model, the archival role of publishers is in question because they might not maintain old material that is seldom requested because it would not be cost-effective and enhance business

- "The publishing industry will assume responsibility for primary distribution of the new media. That distribution may well be done on demand, however, rather than in press runs ... Publishers could then operate ... 'information utilities,' supplying the local retailer and, we hope, the library ... Purchasing and stocking might be online through a high-speed connection to the publishers ... Once an item is acquired by the local center, only copies of it are made so it never need be restocked ... Seven-Eleven Food Stores might become a major outlet. You could fill the tank of your car, eat a fast-food snack, and pick up bread, milk, and a complete, annotated library of Russian literature on the way home from work!"

  (DeBuse 1988, 16)

- "On a network, to read is to own."

  (Seiler 1989, 69)

Explanations:

- " ... A conventional publisher or group of publishers might begin marketing their goods electronically. Or, perhaps most likely, a consortium of interested parties might be formed to develop and exploit the new market as a completely private sector enterprise ... Such a consortium could include publishers, recording companies, video manufacturers, equipment manufacturers, broadcasting and television companies."

  (Martyn 1991, 298)

- "Possible mechanisms for distribution of electronic texts are numerous and are likely to become increasingly affordable. Individual institutions might choose to maintain local repositories of frequently used titles; some publishers might insist on retaining their texts themselves, distributing them on a fee-for-use basis; collaborative arrangements might emerge between consortia of libraries. Who will pay and how much are still unanswerable questions."

  ("What presidents need to know" 1993, 3)

- "One possible future scenario is a division of the research libraries into collection-based and access-oriented libraries. Publishers might reach agreements with the collection-oriented libraries to permit those libraries to resell information to the access-oriented libraries directly, thus avoiding the need for the publisher to mount network-based article supply servers and respond to large numbers of article-level requests."

  (Lynch 1993, 14)

In the acquisition-on-demand model, much discussion has been given to the dissemination of digital artifacts. Publishers could market directly to end users, they could establish one or more new organizations to market their publications to end users, or they could also use libraries as intermediary distribution channels. Regardless of the particular agent of dissemination, publishers will demand payment for various levels of artifact usage in digital libraries characterized by the acquisition-on-demand model.

- "If everything is available and can be supplied electronically, then either the library system gives everything away free of charge or at a subsidised price, in which case the booksellers and probably the publishers die out; or libraries charge an unsubsidised price (paying the publishers a royalty on each 'sale'), in which case the libraries and booksellers are indistinguishable and the public library service has effectively disappeared."

  (Martyn 1991, 298)

- "Some information we may wish to retain indefinitely, other information we may wish to read and then discard, yet other information we may wish to sample or browse through. Some we may not wish to read at all, but will want to have as part of a database for our software-based intelligent 'assistants' to 'read.' Different payment methods will need to be devised to handle these different situations, which in turn will necessarily be reflected in library borrowing policies."

  (Kurzweil 1992c, 64)

- "With electronic books, it might make more sense to pay for person-minutes rather than the less meaningful concept of 'copies' ... In the virtual world, the limitation could be reflected in a finite number of lending minutes, which would be equitably distributed to a library's patrons ... A reasonable means of restricting access while still fulfilling the democratic goals of the library system will need to be found."

  (Kurzweil 1993, 54)

- "Because books are not consumed on delivery, storage of some kind is implicit, so, unless the storage medium is transient or there exists a software or hardware fix for restricting the reading of downloaded text to one or a small number of users, in effect the user would permanently possess a copy of the text and the transaction equates to the purchase of a commodity rather than the use of a service. Copyright considerations are obviously involved."

  (Martyn 1991, 295)

- "If digital publishers determine that it remains worthwhile to give libraries access to their works, they will almost certainly seek to condition that access upon compliance with a variety of restrictions. Publishers may wish to prevent certain kinds or quantities of user reproductions, or to charge for all uses over single viewings of the document. Publishers could enforce these limitations directly if the library is simply providing the user with a computer connection to the publisher. Publishers then could themselves limit initial access (onscreen viewing) to certain categories of users; they could prescribe a maximum number of bytes to be reproduced by printing out or downloading; or they could completely prohibit downloading."

  (Ginsburg 1993, 60–1)

Rationale:

- "The new form of publishing I foresee is that we will not only have a repository network for the instantaneous availability of all documents to all screens, but this system will carry automatic royalty and allow for multiple users of the same material ... You don't have to buy the whole document, you just pay as you go, buy the first three paragraphs, or the tenth illustration ... What will drive the system will be the thrust of a million people who have computers and who want documents *now* on some particular subject of interest. The publisher will just put the magazine or journal or book in the repository, and it will be available. The movement will be one of those ground swells that ignores professional committees and the titanic meetings of Congress and simply happens ... If you ask who is in charge of the whole network, then the answer is that no one is in charge. It is a software system that maintains a universal addressed space wherein any document may be located and that may grow indefinitely. Anyone may publish a document by paying one of the service providers."

(Nelson 1993, 14–17)

In the library literature, the authors found few rationale statements for the acquisition-on-demand model. Ted Nelson feels that end-user demand for information will drive its adoption. What also may be the driving force behind this model is its closeness to the existing model of scholarly communication.

Caveats:

- " ... To move to an acquisition-on-demand model under which a library acquires individual journal articles only when a patron requests them, rather than subscribing to the journal. But it seems certain that publishers will set the article prices for acquisition-on-demand to keep their existing revenue streams (at least) constant ... It is easy to imagine publishers applying information technology to vary prices of articles over days or weeks, based on usage levels, topic interest, citation analysis, or media coverage."

(Lynch 1993, 11)

Librarians have voiced considerable opposition to the acquisition-on-demand model. Variations in pricing for low- and high-use materials concern librarians. There are much larger issues: the concern that this model will lead to an increase in the gap between information "haves" and "have-nots," and the concern about the long-term preservation of knowledge.

- "While this [pay-per-publication model] may be an important intermediate strategy to offset some of the spiraling inflation costs which are being experienced, this model is not consistent with the values of the academy or of society at large. If a purchase-per-copy model were adopted, several outcomes are likely. Since it is access, not ownership that is being purchased, the cooperation which has historically occurred between the wealthier institutions for access — via interlibrary loan — to more esoteric information, the schism between 'haves' and 'have nots' would increase even further … Because this is a commercial venture, it is unreasonable to expect such entities to be able to meet esoteric demands, as the sheer lack of demand associated with such materials would not cost-justify providing such access … If the knowledge of our civilization is to be preserved and made accessible, then dependence solely upon a marketplace philosophy would be disastrous."

(Hawkins 1993, 13)

7.4 Not-for-profit corporation model

- "An independent non profit organization ... would be a single focal point for negotiations and central brokerage, eliminating unnecessary costs and duplication, leveraging resources, and promoting standards ... It needs to draw upon both general philanthropy as well as voluntary support and tangible contributions of its 'clients' ... Thus voluntarism will hopefully take the form of institutions actively working to make resources which they 'own' and to which they have legal copyright, available in electronic format and give this electronic library the rights to make these resources available to its patrons in a nonexclusive manner."

  (Hawkins 1993, 15–16)

- "In 1998, responding to pressure from librarians, academics, publishers, and the general public, Congress approves a one-line change to the tax code. Publishers will now be able to take substantial write-offs for every subscription and book sold to libraries. A $1,000 journal now costs libraries $29.95."

  (Dillon 1992, 513)

The goal of the not-for-profit corporation would be to promote universal access to scholarly material. Support from institutions of higher education would make the corporation a powerful force in negotiations with publishers for alternatives to current copyright management. It would also negotiate national and international site licenses with publishers, define standards, support the development of network organization and access tools, and promote tax incentives to encourage publishers to make contributions for the public good.

7.5 Centralized model

Descriptions:

- "One unresolved question is the degree to which e-text holdings might eventually be centralized. Archival copies could be stored in a central repository, or at one of several regional sites, 'scanned on demand,' then transmitted to the requester online or on disk ... Electronic file transfer would replace interlibrary loan and photoduplication requests ... If the system works, books should follow."

  (Basch 1991, 21)

The creation of a centralized collection of digital resources has been suggested. The key issue in the development of this model is the organization that controls access to the centralized collection. Only John Franks' description of the database model is specific about who controls the collection.

- "The trend will be to increasingly centralize information and the technical staff necessary to keep the system operating. The point where centralization will stop is probably where economies of scale for storage balance those of increased communication costs over longer distances."

  (Seiler 1989, 68)

- " ... The gathering of a single comprehensive collection, including all extant current, past, and future scholarly publication ... Publication of a work of scholarship would be accomplished by its deposit in a generally accessible electronic database, where its index would be integrated with the indexes of all other publications, and it would be properly cataloged ... Scholars would benefit through prompt publication, the removal of external limitations on publishability, and improved access."

  (Smith 1992, 50–1)

- In the database model, all articles reside on a centralized database maintained by the publisher; subscribers get the right to access the database and use search software on the central computer to locate and download articles of interest for printing. An example of the database model is the Lexis/Nexis model. This model has certain disadvantages: charging for search software use, archival functions performed by publishers, the requirement that scholars go to libraries and consult an intermediary who performs the search.

  (Franks 1993, 5)

Caveats:

- "It is hardly possible that all materials likely to be requested should be stored at or delivered from a single locations ... because of the sheer volume of traffic (about two million transactions per day)."

  (Martyn 1991, 297)

- "All that matters is that the local nodes are able to locate requested material, and arrange for its transfer to users via themselves. It would probably be reasonable to think in terms of regional stores, with a central 'last resort ' backup store, a regional store being a cluster of sub-stores each holding a group of subjects or a particular class of material."

  (Martyn 1991, 298)

John Martyn offers caveats about the notion of a centralized model. He is concerned that the volume of transactions might make the model unfeasible. He also suggests that the scattering of digital resources across the network material is not so much of an issue as the ability of a requester to locate a particular item and transfer it to a desired location.

7.6 Governmental model

Description:

- The governmental model ... would be supervised and funded by the United States government. The federal government has always played a prominent role in funding the archiving and distribution of information, and the development of an electronic information infrastructure is part of the new President's agenda."

  (Hawkins 1993, 14)

A digital library model supervised and funded by the United States government has been suggested as a means of providing universal, subsidized access to information.

Caveat:

- "While it can be strongly argued that government investment in support of an electronic library accessible to all colleges, universities, high schools, etc. would have strong impact for the common good, dependency on governmental funding is not a desirable solution. At least for the foreseeable future, the priorities of a sagging economy do not speak well for the level of funding which would be necessary ... A second major concern surrounds the recent dialogues regarding public funding for the National Endowment for the Arts, and the subsequent discussions regarding governmental censorship have the potential of working at direct odds with the strong commitment necessary of educational institutions and libraries alike to make *all* information available. Finally the temptation to fall into the trap of ethnocentrism, creating a national electronic library must be avoided."

(Hawkins 1993, 15)

In view of today's economic conditions, this model is probably not feasible. The likelihood of governmental censorship is another also strong argument against this model.

7.7 Other models

Descriptions:

- "An entertainment model, a model which is already in place, ... will certainly continue to play a major role in consumer-oriented networked information services in the near future ... This model is exemplified by (US) network and cable television [and] relies upon the large audience of consumers willing to pay directly for access to information ... This model seems to favor content with broad appeal and thus will ultimately tend toward content such as highly digested news, tabloid sensationalism, and video formats. Unfortunately there is little reason to believe that the entertainment model could successfully support electronic access to research libraries, to video collections of museum artifacts, or to a pursuit of depth or cultural value in any arena."

(Hawkins 1993, 13)

Four other models appear in published literature on the future of the library. Since these four models and the models in previous discussions were generated before the mergers of telephone and cable companies, writers have not speculated the effect of these mergers on network access. In view of these mergers, we could expect the entertainment model to make significant gains in the near future. Subsumed in the entertainment model is edutainment software that is likely to make great gains in the marketplace in the coming year.

- "There are even those — software makers, mostly — who contend that the lively animation and sound of multimedia has kids spending more of their time doing homework. That's helping to drive the rapid growth in a new category of 'edutainment' software. These are programs that look like games but actually teach something, in a way that feels like fun … Edutainment is also symbolic of a unique phenomenon in multimedia. This is the first significant computing technology to be initially adopted by consumers rather than business customers."

  (Arnst 1993, 169)

- "General-purpose libraries, each like a Library of Congress but holding more information, will be located regionally. Such regional libraries might be sold as turnkey systems with a common hardware platform and bundled with identical collections of information and software."

  (Seiler and Surprenant 1991, 30)

- In the software model, subscribers get a piece of software to perform searches, download results in a proprietary encrypted form which the software decrypts and displays results. The software has an expiration date which system compares to centralized server to assess whether the subscription is current. The advantages and disadvantages of this model are similar to the database model, i.e., charging for search software use, archival functions performed by publishers.

  (Franks 1993, 6)

- In the subnet model, electronic information is distributed only to clients with certain Internet protocol addresses to ensure that only addresses within the institution that holds the license for the information are served. The advantage of this model is that publishers could grant archival rights to licensees. A disadvantage to publishers is the inability to charge for searches and connect time.

  (Franks 1993, 8–9)

7.8 Favoring one model over others

Although certain models have strong advocates, some writers are hesitant to favor one model or another — claiming it is too early to determine the favorite, stressing the diversity of the user community, highlighting the different missions of the various players, and so on.

- "Of course no single model will adequately meet the needs of our large and extraordinarily varied community of users, all desiring to use an ever-growing body of information, existing in an increasing set of formats and media. It is unreasonable to expect any single model to act as an umbrella for the entire set of information needs of our society. However, it is extremely disturbing that little if any movement is being made to develop models [that] could serve the scholarly, educational, and academic needs of our society in the coming decades. There is a desperate need for a model or a plan, so that various stakeholders can critique, amend, and amplify an initial proposal, resulting in a framework from which we might begin discussion."

  (Hawkins 1993, 10)

- "We are not far enough along in the transition to a fully electronic environment to know what new forms and institutions may ultimately emerge."

  ("What presidents need to know" 1993, 4)

- " ... There are unlikely to be any solutions devised which are universally applicable to all campuses. Campus strategies will, in large part, reflect the local missions, traditions, availability of funds, and prevailing local attitudes. Each campus needs to identify its own preferred set of images, not only to plan a new campus information environment, but also to chart other aspects of the academic enterprise."

  (Dougherty and Hughes 1991, 17)

- "Options for electronic text distribution are many, and no one can predict which will prevail, where, or how. Individual institutions might choose to maintain local electronic repositories of frequently-used titles; on the other hand, some publishers might choose to retain their texts themselves at central sites and distribute them on a fee-for-use basis; collaborative arrangements between repositories of various kinds in various places may emerge in which a consortium of libraries, say, may together hold a full set of resources, without each institution having to pay the full cost of housing such a set."

  (Cummings et al. 1992, xxvi)

- "It is extremely unlikely ... that any alternative model for scholarly communication will completely supplant the existing one in the foreseeable future."

  (Cummings et al. 1992, 165)

7.9 Opening a dialogue among stakeholders

Bloodsucking leeches:

- " ... Librarians and journal publishers had one thing in common — each regarded the other as a bloodsucking leech. Things are better, but developing a ubiquitous digital library system will require both new levels of cooperation among the key stakeholders and, more important, new levels of trust ... It's going to get hot inside the tent as we work together to address these exhilarating challenges and build the working prototypes of a comprehensive digital library system."

  (Garrett 1993, 21)

John Garrett uses the phrase "bloodsucking leeches" to describe how librarians and journal publishers view each other. Both Garrett and Harold Billings make strong statements about the need for these two factions to rise above suspicion, competitiveness, and hostility to work toward solutions that will benefit all players in the scholarly communication arena.

- Too much suspicion, competitiveness, and hostility prevail between the public and for-profit camps, despite the fact that information vendors have been using libraries as test beds and sometime shills for their products, and perhaps because of the fact that libraries themselves are becoming hucksters of systems and information products."

(Billings 1993, 35)

The need to work together:

- "We need to come to an agreement with existing rights holders that will allow current printed-based scholarly publishing to make the transformation to networked information ... For the foreseeable future, this form of networked information really will be printed information that is stored and delivered using electronic information technology. Its tradition is the print tradition; its management is based on the management of printed journals. Virtually all of it will be published both electronically and in print."

(Lynch 1992b, 110)

- "Above all, perhaps, librarians and publishers should sit down at a table of common purpose and join again in what has always been a necessary partnership: to publish and make available the ideas and creative work of authors ... Each has developed an intransigence based on the use of copyright as both a weapon and a defense that prevents restoring their longtime association."

(Billings 1993, 36)

Harold Billings sums up the need for the various players in the digital library arena to work together with the statement, "librarians and publishers should sit down at a table of common purpose and join again in what has always been a necessary partnership."

- "I believe that the best strategy for overcoming the bottlenecks of timeliness, affordability, accessibility, storability, and availability will occur with a process that is built on a cooperative basis among the present players. I would argue for this approach because the alternative (i.e., bypassing or eliminating one of the current players) is more likely to lead to more bottlenecks that had previously been overcome."

  (Penniman 1993, 8)

- "Rather than spending time and money on attempts to eliminate the role of commercial publishers or take over their functions, librarians could engage more productively in a joint effort with publishers to achieve recognition and greater funding."

  (King 1990, 29)

- Key elements of a successful electronic copyright management service: (1) "any successful system must consider the overlapping and competing requirements of the different stakeholders, and must include them, or their representatives, at the initial stages of concept development, design, and implementation, (2) the planning and development process must allow time and occasion for the various stakeholders to discuss and resolve issues which make an impact on automated copyright management ..., (3) stakeholders will need to be ready to compromise in some areas in order to achieve their goals in others."

  (Garrett and Lyons 1993, 471)

- "Many concerns about the management of the networks that distribute this materials are already begin articulated. Who has access, who pays, who worries about integrity of texts and privacy, who monitors ownership and legitimate user? Academic institutions, individual scholars, and their commercial partners in the transactions to come will all have their own agendas, and they must learn to work in an atmosphere of mutual respect and cooperation."

(Cummings et al. 1992, xxvii)

Undertaking pilot projects:

- "Above all there is a need to mount pilot projects that will test and demonstrate various capabilities of the new technologies. The pilots will have to take into account the current constraints of the academic culture, provide necessary incentives and rewards for risk-taking, recognize the differences among disciplines in information gathering habits of researchers, build alliances where competition and mistrust now prevail ... We believe that progress will be slow for a variety of reasons: the intractability of campus cultures, the complexity of managing multi-institutional pilots, and of course existing funding constraints."

(Dougherty 1993, 55–6)

- "Earlier advice from the Council on Library Resources seemed not to have been heard: 'A few well-chosen projects can begin to move us toward a more rational environment in which both information producers and information consumers are served well by libraries ... One such project is TULIP ... Another especially appealing one is the Red Sage Project.'"

(Penniman cited by Billings 1993, 37)

Now that the various players are seated at the table, what should they talk about? Several writers urge the players to design and implement pilot digital library projects. These projects would test capabilities of the latest technology for delivering digital information resources, teach the various players about users and uses of digital library resources so that they can design usable systems and develop reasonable guidelines for information access and use, and teach the various players about the changes in the economics of information from creation through presentation.

- "This points up the need for careful experiments with access to protected works over computer networks and other telecommunications systems in order to develop acceptable practices and guidelines for producers and consumers in the digital library community."

  (Garrett and Lyons 1993, 472)

8 Stakeholder motivations and concerns

Before launching digital library projects, stakeholders need to lay their motivations and concerns on the table so that the various parties involved in these pilot projects increase their understanding of each other and accommodate their various concerns in the design of usable systems and the development of reasonable guidelines for information access and use. This section reviews the motivations and concerns of the following digital library stakeholders: (1) authors, (2) publishers, (3) librarians, and (4) end users.

8.1 Authors

Author motivations:

- Recognition.

  (Anderson 1993, 91); (Cummings et al. 1992, xxv)

- Promotion and tenure.

  Supporting: (Anderson 1993, 91); (Butler 1992, 103); (Triangle Research Libraries Network 1993, iii); (Sutton 1992, 7); (Peters 1992, 57); (Lyman 1991, 41); (Anderson 1993, 88); (Mitchell and Saunders 1991, 11); (Seiler 1989, 14); (Yavarkovsky 1990, 18); ("What presidents need to know" 1993, 2); (Cummings et al. 1992, xxv)

- To ensure that the electronic scholarly record is preserved, fixed, and unchangeable to provide a foundation for new knowledge.

  (Anderson 1993, 95)

There are no surprises in this list of reasons why authors publish scholarly works. Digital libraries must support author motivations to ensure uninterrupted scholarly production.

One reason why authors publish — to ensure that scholarship is preserved, fixed, and unchangeable — overlaps with the mission of libraries.

Listed author motivations describe why authors participate in formal communication — the point in time when authors enter their work into the permanent record.

- "To inform their peers of their findings, and equally important, to *be* informed by them in turn, to *interact* with them ... In a word, the purpose of scholarly publication is *communication* — with peers, and for posterity."

  (Harnad 1992, 58)

  Also supporting: (Triangle Research Libraries Network 1993, iii); (Anderson 1993, 91)

- To advance human inquiry.

  (Harnad 1992, 58)

- "While a scholar's strongest motivation in selecting a journal for his work will likely be to place it in the most prestigious journal which will accept it, it seems likely that other factors being equal he or she will opt to publish in a subsidized journal where the article's exposure is likely to be greater."

  (Franks 1993, 11)

  Also supporting: (Anderson 1993, 88)

Missing are author motivations for engaging in informal communication, e.g., distributing preprints, responding to requests for comment, participating in list serves, responding to electronic mail. Digital capabilities will make it possible for formal and informal communication to be brought together and blur distinctions between the two forms of communication.

The marriage of formal and informal forms of communication will foster new forms of literature, new digital library models, new partnerships, and new alliances among the various digital library stakeholders.

Author concerns:

- "One of the most common questions raised by academics in discussions of such projects [e.g., OMIM (On Mendelian Inheritance In Man) database of Richard Lucier and Nina Matheson, Bruce Schatz's worm project] is whether such work, unlike traditional print journal publications, will be of value to the authors when they are considered for tenure and promotion ... Another aspect that makes evaluation difficult under traditional criteria is the intensive collaboration that is usually behind such efforts, which often brings together researchers from multiple disciplines."

  (Lynch 1993, 9)

Authors may not embrace digital libraries with open arms. In promotion, tenure, and merit raise decisions, they wonder about the recognition their institutions will give them for the creation of digital artifacts and how citation counts will be handled. They also must learn how to exploit the new technology of digital artifacts, possibly going so far as to create new forms of literature.

- Authors are reluctant to alter or tamper with the goals of recognition and peer communication that come from publishing in print-based journals, thus, making commercial publishers reluctant to charge forward into the transformational world of electronic journals.

  (Anderson 1993, 92)

- "Authors are justifiably nervous about citation counts being used to decide whether an item should be retained in the system."

  (Piternick 1991, 27)

- Authors must learn how to exploit the new technology of electronic documents — text, video, stills, audio — to present their ideas effectively.

  Supporting: (Anderson 1993, 97); (Lanham 1990, 35)

8.2 Publishers

Publisher motivations:

- "Going to electronic books and electronic distribution of them on demand means no printing and its costly consequences: warehousing, transportation, delay, and backordering; competing for scarce outlet shelf space; overestimating demand and having to remainder or destroy books; underestimating demand and having to lose business or annoy customers; and sinking large amounts of capital into paper copies that take time to sell, take up shelf space, decay on the shelf, may be returned after sale, and if sold then fuel the used-book market."

  (Rawlins 1993, 477)

- "When publishers recognize that they can generate revenues from electronic publications, commercial publishers will become very active participants."

  (Anderson 1993, 92)

- "Publishers — especially print publishers — have determined that whatever is in the computer can be counted."

  (Martin 1989a, 403)

- "Information access by transaction is a market virtually waiting to explode —a consumer-driven market that can better feed authors and publishers, as well as allow libraries to reduce some of the huge costs of journal subscriptions and monographic acquisitions and the unseen overheads that support paper-based library collections."

  (Billings 1991a, 41)

Except for the list of publisher motivations suggested by Gregory Rawlins, the authors find few motivations for publishers to pursue the production of digital artifacts. We could attribute this to the literature we reviewed. That is, nearly all literature is written by librarians, educators or administrators at institutions of higher education, library systems or computer systems directors, and, thus, reflect their points of view.

The potential for generating more revenue from the publication of digital artifacts than paper-based documents may be the single most compelling motivational factor behind the conversion of publishing to digital environments.

Publisher concerns:

- "Bundling articles together as issues and issues as volumes is a convention based on paper technology and printing. This process does not meet our new needs for access to particular information anytime, anywhere. In the future, the article may well be the basic unit of academic information for users."

  (Gherman 1991, A36)

  Also supporting: (Cummings et al. 1992, 131); (Nunberg 1993, 23)

- "The publishing industry is in chaos as it seeks to maximize profits on its paper formats while attempting to develop new markets for its electronic products ... The true costs of electronic publishing are essentially unknown and represent an entirely new set of interdependencies among the author, publisher, and customer."

  (Battin 1989, 378)

- "The paper journal ... has also been a valuable medium for delivering advertising and subscription revenue to publishers. This is an important concern to address in the online environment — the economics of electronic publishing are not simple or obvious ... Compensation for those providing publications to the network would be made by negotiated contractual payments to commercial and association publishers for their contributions to the network or by royalty payments to publishers and authors. The Copyright Clearance Center might play a role in these transactions, but new agencies, analogous to ASCAP and BMI in the music industry, might emerge ... There are other possible approaches ... Subscription fees might be based on anticipated use of subsets of a node's publications ... Alternatively, payment might be made for each use of a publication."

  (Yavarkovsky 1990, 17)

This list of publisher concerns is much longer than the list of publisher motivations. In the evolution from print-based to digital products, publishers must address issues such as the practice of bundling articles into issues and volumes, the place of advertising in digital products, collecting royalties, maintaining a print-based production and distribution system while switching to a digital system, and accommodating end-user access and usage of digital products.

Publishers cannot necessarily resolve these issues on their own. Patricia Schuman's statement, *"I have no idea how a user might access a single part of a 300-page book — or how often. I have no idea how to find out. And I am not alone"* may be a plea for assistance from librarians and other stakeholders to join her and other publishers in resolving issues concerning publishing in digital environments.

- "For most publishers, electronic publishing is conceptually uncertain at best and economically risky at worst ... I have little faith in an electronic distribution system that pays a royalty per use for a publication ... But I have no idea how a user might access a single part of a 300-page book — or how often. I have no idea how to find out. And I am not alone."

  (Schuman 1990, 37)

- "The problem is that there is no mechanism to support electronic distribution with the control desired by publishers."

  (Butler 1992, 105)

- "It is hard to see how a lucrative industry that is doing very well, thank you, would have any incentive to change to a method of publishing with murky financial prospects."

  (Gorman 1991, 7)

- "It is not clear what direction commercial publishers will take. At the moment they seem generally conservative and uninterested in innovating."

  (Franks 1993, 11)

- "From the publisher's perspective, there seems only the very weakest and most speculative justification for all-electronic publication as a business venture today. Starting all-electronic publishing ventures today is a risky venture, perhaps best taken by nonprofit organizations to improve service to their constituencies."

  (Anderson 1993, 92)

8.3 Librarians

Librarian motivations:

- Financial pressures: "(1) contrary to conventional wisdom library budgets have tended to increase less rapidly than other university expenditures, (2) the rate of increase in books acquired by university research libraries virtually halted in the 1970s and 1980s, while the number of titles published domestically and internationally has increased at a rate of at least 2 percent per year, (3) price increases have driven a 'serials crisis' which is a major contributor to library difficulties today. Serials expenditures have increased steadily for 30 years, at an average rate of 11.3 percent per year from 1963 to 1990, compared to 7.2 percent per year for book prices."

  ("What presidents need to know" 1993, 1)

- "There is growing realization that no research institution can sustain a self-sufficient collection into the indefinite future."

  ("What presidents need to know" 1993, 2)

- Reduce journal subscription costs.

  Supporting: (Rochell 1987, 46); (Wegner 1992, 84)

- "There is much more interest and impetus from libraries to enter electronic publishing than exists in the commercial publishing industry."

  (Anderson 1993, 92)

Underlying Greg Anderson's assertion that *"There is much more interest and impetus from libraries to enter electronic publishing than exists in the commercial publishing industry"* may be the recognition that libraries have to find ways of reducing costs.

Secondarily, librarians are closer to users than publishers and, thus, have a better understanding of academic culture. They may also be under more pressure from campus leaders than from publishers to explore digital access.

Librarian concerns:

- "Modernization will not substantially reduce publisher charges to libraries for their goods. This is only wishful thinking. In fact, due to investments in technology, modernization may actually increase the price of acquiring published material in the near term. So publishers are showing a propensity to amortize and recover the expenditures they are making to upgrade their production systems over rather short time horizons, leading to increased prices. And, certainly, publishers will not view new electronic product offerings as a justification for reducing existing profit margins through price cuts."

  (Lynch 1993, 10)

- "It is unlikely that [electronic journals] will ever ... lead to significant reductions in the costs of many high-priced scientific journals."

  (McDonald 1991, A6)

- "E-journals will offset the costs of subscription fees; *or* they will break the back of libraries, because they will require new subscriptions rather than maintenance of existing subscriptions."

  (Langschied cited by "The impact of electronic journals" 1991, 185)

Librarian concerns focus on the inability to control costs connected with access to digital artifacts — especially costs that would be exacted by publishers under the acquisition-on-demand model of digital libraries. The strong support expressed for the noncommercial publishing model may be a response to this inability, that is, this model has the greatest potential for controlling publishers (i.e., leaving them out of the model entirely), and, thus, reducing costs.

8.4 Concerns shared by stakeholders

Concerns about copyright:

- A general concern about the copyright of original material placed on the network.

  Supporting: (Sutton 1992, 7); (Gapen cited by Saunders, 1992b, 67); (Gapen 1993, 2); (Lyman 1991, 41); (Mitchell and Saunders 1991, 11); (Hoffman 1992, 35); (Rochell 1987, 46); (Weber 1990, 78, 80); (Cummings et al., xxvii)

- "Digital libraries will require more authorizations and more payments from more users to more rights holders than has ever been contemplated in a nondigital world. Rights and royalties management will need to link and authorize access to information in many different forms, created and distributed under diverse rights-owning systems (e.g., print, film, sound, photographs) ... The digital library systems must include a copyright management system that: (1) provides for confidential, automated rights and royalty exchange; (2) ensures owners and users that information is protected from unauthorized, accidental, or intentional misattribution, alteration, or misuse; (3) ensures rapid, seamless, efficient linking of requests to authorizations for information use; and (4) encompasses effective billing and accounting mechanisms."

  (Garrett 1993, 19)

- "Any movement to make major alteration in copyright law will require a major national consensus. Such a consensus has not yet developed and is likely to be many years in forming. The widespread sharing of full text awaits appropriate changes in copyright law."

  (Heterick 1990, 10)

- "We will be dealing with questions of copyright and fairness, and fair use, well into the twenty-first century."

  (Martin 1989a, 403)

Stakeholders express concern about copyright in digital library environments. Since copyright is connected to costs, librarians are likely to favor models in which libraries have control over copyright, e.g., the noncommercial publishing model, and, possibly, the not-for-profit corporation model. Publishers may favor the acquisition-on-demand model, because they have control over exacting remuneration for copyright. Most likely, digital library systems will have copyright management modules that compensate intellectual property holders for various levels of artifact access. Compensation may come from libraries, end users, or both.

- "Basically, copyright provides no rights to licensed electronic information except those given by license by the rights holder. For example, the shift to license is eliminating ideas like fair use and the interlibrary loan system since these are not part of the license terms. These are serious matters — these are basic public policy issues. In this sense, copyright is not a problem: It's an irrelevance."

  (Lynch 1992b, 109)

- "One might first inquire why copyright law is at issue at all. In the world here posited, the publishers abandon copyright and seek to regulate all use by contract, on the premise that where copyright's protections have nothing more to offer them than do contract and technological controls, copyright taken together with its exceptions, particularly fair use, offers them less. In pressing a contract claim, the publisher is seeking to achieve copyright-like protection, unencumbered by copyright's countervailing limitations."

  (Ginsburg 1993, 61–2)

- "Existing copyright may be inadequate for the 'library without walls.' But substituting a contract regime may become far too burdensome, at least from the library's perspective."

  (Ginsburg 1993, 67)

- "Institutions cannot negotiate thousands of separate contracts for electronic information, nor can they manage electronic information under this diversity of obligations."

  (Lynch 1992b, 109)

Stakeholder interdependencies:

- " ... An electronic library must coexist with other structures, both commercial and public, which also serve to provide information via the network ... The survival or lack of survival of publishers or any other player in this marketplace will be a direct function of the value and resources which they add to the process."

  (Hawkins 1993, 12)

- " ... I believe the players are looking hard at the value-added aspects they bring to the table, and will be forced to look at the marketplace, and economic factors that will separate feasibility from viability."

  (Penniman 1993, 9)

- "There is, without doubt, a conflict of interest among the stakeholders in the current system of scholarly communication. Today we have a balance of these conflicting interests that is working less effectively each day. Finding a new balance will require both cooperation and (constructive) confrontation. It is clear that there are well-entrenched vested interests, including publishers, academics, and attorneys, in the current state of affairs. This is a multi-billion-dollar business, and the players want only to move the current balance modestly and slowly. Unless something changes radically, the dawn of the age of widespread networked information may look very different than we might expect."

  (Lynch 1992b, 108)

Here are some general, unrelated statements about stakeholder interdependencies. The first two selections comment on the value-added aspects that the various stakeholders bring to the table.

- "I believe there are compelling reasons to change the current system of prepublication, peer-review refereeing. The whole framework of 'rating' and filtering scholarly output by publication in peer-reviewed journals should be replaced with something better tuned to the possibilities of networked information. But I find myself wondering how we will find out what works and what doesn't. Authors have too much at stake to experiment; it will not be until the needs of the community as consumers overwhelm each individual's needs as author that change will occur. And this will be slow; almost every consumer is also an author."

  (Lynch 1992b, 108)

- "These stakeholders [university administrators, information technology managers, university librarians, faculty, scholarly publishers, academic association/foundation leaders], plus others, need a means to continue and expand their contacts with each other. Insufficient interaction now exists. Stakeholder interdependencies will make it difficult, if not impossible, for any single group to achieve its own goals unless it can successfully establish alliances and collaborative strategies based on the intersection of its priorities with those of other stakeholders."

  (Dougherty and Hughes 1993, 1)

- "Among the barriers to electronic publishing are ... lack of good models for operating and managing a 'legitimate' electronic journal."

  (Anderson 1993, 88)

- "Traditional roles in the publishing process will undergo transformation. There may be some blurring in the distinctions among the historical roles of publishers as producers, vendors as intermediaries, and librarians as archivists."

  ("What presidents need to know" 1993, 3)

- "No other system of providing

  (i) reasonably reliable information on serious research projects which permits avoidance of duplication and provides incremental data;

  (ii) reasonably valid evaluations of the quality of research projects;

  (iii) a generally accepted means for justifying academic promotion, tenure decisions and research grants.

  has yet been devised — not at least one which would be easier to run and would cost less."

  (King 1990, 25)

8.5 Future users of digital libraries

User motivations:

Online library systems have raised user expectations.

- Raised expectations due to success of online systems — people expecting materials from anywhere in the world almost instantaneously either in electronic form or in hard form printed or by long-distance facsimile transmission.

  Supporting: (Drake 1990b, 170); (Olsen 1990, 236); (Farber cited by Riggs and Sabine 1988, 17); (De Gennaro cited by Riggs and Sabine 1988, 18); (Drake 1988, 115); (Metz 1990, 31)

General concerns:

There is little speculation and even less research about future users of digital libraries. Cited selections describe librarians' observations about users. They also describe the library of the future as a place people visit.

- "And people still want browse. Not all users know exactly what they want. It is that element of library use that some of the technological systems overlook. You have to know very precisely what you want before you can find out by technological means whether it is there."

  (Eastman cited by Riggs and Sabine 1988, 26)

" ... Faculty want materials on campus. They don't want to be dependent on other distant libraries for needed materials. Many of them also, because of the structure of their disciplines, still depend on at-the-shelf browsing."

(Dougherty and Hughes 1991, 6)

Information "haves" and "have nots:"

- "The general public will become increasingly information poor."

  (Lynch 1992a, 33)

  Also supporting: (Galvin 1990, 3)

- "Aside from those users who can affiliate with some academic or special library with the funding to underwrite their access to information, the general public will have to fund their own access to information or lose access altogether."

  (Lynch 1992a, 33)

- Explore a subsidy such as "information stamps" to those who are unable to pay.

  Supporting: (Surprenant and Perry-Holmes 1985, 235); (Seiler and Surprenant 1991, 152)

- "Libraries will supply information primarily to those who cannot afford to buy it from private companies. Libraries are seen to have roles as equalizers in access to information by providing the technology and the account number or the print and manual alternatives for those who cannot gain access to information any other way."

  (Woodsworth and Hoffmann 1988, 93)

- Libraries will always be around because they have a monopoly on their mission, that is, providing information for the public good, especially for "the ones who are too broke to buy the information they need."

  (Berry 1991, 6)

Regardless of the particular model underlying digital library environments, keepers of digital libraries may have to exert greater controls over information access than in paper-based libraries because of copyright regulations, licensing restrictions, etc. Despite information-access subsidies, the gap between information "haves" and "have nots" is likely to increase because of charges levied for various levels of access to digital artifacts. This section cites selections that speculate on information "haves" and "have nots" and what librarians can do to lessen the gap.

9 Digital library projects

This section enumerates key details on ongoing digital library projects, products, or services. The following information is given in individual entries for digital library projects: (1) name, (2) years in which the project was active, (3) principal institution — usually the institution that initiated or created the project, product, or service, (4) partners — organizations that may be project participants, sponsors, principals, or test sites, (5) objectives, (6) content, (7) hardware/software, and (8) sources of published information on the project.

Clifford Lynch (1992b, 111) assesses digital library projects with the statement, *"The experiments we are seeing today are basically conservative. They are very close to the print tradition."* That is, these projects enlist new technologies to automate what digital library stakeholders have been doing manually. Despite his statement, these projects are important because they involve several digital library stakeholders — publishers, librarians, digital library systems designers, end users. Hopefully, the findings of these projects will help the various stakeholders identify their respective roles in the library of the future.

9.1 ADONIS

Service name: ADONIS (Article Delivery Over Network Information System)

Related project: Project QUARTET

Principal institution: Adonis.

Years: Mid 1980s–

Partners: Originally a publisher consortium of Elsevier, Springer-Verlag, Pergamon, Blackwells, Acadata and John Wiley. Since 1991, Adonis has been a for-profit company that subcontracts indexing to Excerpta Medica, scanning to Satz Rechen Zentrum, disc production to Nimbus, and software development to Lasec.

Pilot project objective: To investigate the issues involved in electronic document delivery utilizing CD/ROM technology, assuming that technology had reached the point where the evasion of photocopying royalty payments by intermediaries could be eliminated, so publishers could take control of the delivery process.

Objective: To provide a weekly subscription of about five hundred journals on CD/ROM.

Contents: About five hundred scientific and medical journals from the publisher consortium; provides CD/ROM-based indexes (for author names, article title

keywords, journal title, ISSN, publication year, volume or issue number, and article pagination) to help users find journal articles of interest. A future development is the design of an interface between CD/ROM-based documents and online databases containing references to them.

Hardware: (1) standard 386 or 486 IBM-compatible workstation with a CD/ROM disk drive or jukebox (2) Group IV fax machines; (3) software and discs supplied to the library after Adonis receives the subscription fee.

Sources: (Merry 1988); (Pozza 1991); (Cawkell 1991, 62-63); (Landoni, Catenazzi, and Gibb 1993); (Leach and Tribble 1993)

9.2 American Memory Project

Project name: American Memory Project

Years: 1990–

Principal institution: Library of Congress (LC).

Partners: Over three dozen academic, public, special, and school libraries; Apple Computer; IBM; United States Mint; Pioneer Electronic Corporation of Japan, and two private foundations.

Objective: To provide online, on-demand distribution of all types of collections from the Library of Congress to libraries across the nation.

Contents: Examples of subject matter released on the first few laserdiscs: (1) cartoons about Congress, 1770–1981, (2) 25,000 postcards published by Detroit Publishing Company, 1880-1920, (3) broadside documents from the Continental Congress, 1774-1789, (4) films of President McKinley at the Pan American Exhibition in Buffalo, N.Y., 1901, and (5) film of New York City, 1897-1906. Soon to come are laserdiscs featuring: (1) African-American pamphlets, 1820-1920; (2) 1,000 of Matthew Brady's Civil War photographs, 1861-1865, and (3) first-person narratives of California's early years.

Hardware: Generally libraries used: (1) Mac II series PC or Mac LC with a minimum of 2MB RAM, but 4MB preferred, (2) 13" color monitor, (3) color television monitor, (4) videodisc player, (5) CD/ROM drive, (6) frame grabber board to print video images, (7) Laser Writer laser printer. LC supplies libraries with videodisks and CD/ROMs.

Sources: (Bacon 1990); (Polly and Lyon 1992); (Rottman 1992)

9.3 Ariel

Service name: Ariel

Years: 1990–

Principal institution: Research Libraries Group, Inc.

Objective: To design, develop, test, and market software to electronically transmit a wide array of documents in image format (journal articles, photographs, drawings, Chinese characters) via the Internet.

Procedure: The scanner takes a bit-mapped image of the page, compresses it, stores it in the PC, sends it over the Internet to the recipient's PC for decompression and printing.

Hardware: At least an IBM-compatible microcomputer with 640K RAM and 80MB hard disk, (2) Hewlett Packard ScanJet Plus or Panasonic FX-RS506 scanners, (3) Hewlett Packard LaserJet III or II, (4) TallTrees JLASER Ariel adapter for the printer, (5) 3Com Etherlink II card, (6) ethernet connection, and (7) Internet access.

Source: (Jackson 1993)

9.4 CORE

Project name: CORE (Chemistry Online Retrieval Experiment)

Years: Late 1980s–

Principal institution: Mann Library, Cornell University.

Partners: OCLC Online Computer Library Center, Bell Communications Research (Bellcore), American Chemical Society (ACS) including Chemical Abstracts Service (CAS).

Objective: To develop a prototype online information system for the storage, searching and displaying of primary scientific journal text and graphics in electronic form.

Contents: 20 ACS journals from January 1991–September 1992 (20,000 articles/142,000 pages). CORE's goal is to contain all of the American Chemical Society's journals from 1980 to the present and the CAS-supplied indexing and abstracting records connected with journal articles.

Hardware/software: (1) optical storage disks mounted in a jukebox; (2) Unix or Mac IIci with MacX software; (3) ethernet cards; (4) XWindows interface.

Sources: (Landauer 1991, 325); (Krumenaker 1993, 1066); ("Virtual Libraries" 1993, 19); (Landoni, Catenazzi, and Gibb 1993, 177); ("CORE" 1990; 1991; 1992)

9.5 DOCDEL

Project name: DOCDEL experiments

Years: 1983–

Partners: Centre de Documentation Scientifique et Technologique (CDST), Paris; Commission on European Communities, and many organizations under grant or contract to conduct specific experiments.

Objective: To test all aspects of an "electronic document delivery service" by delivering pages of current issues of 100 prime biomedical journals to users requesting them, specifically studying the behavior of scientists in a real fee-paying situation.

Contents: (1) Transdoc: 50–100 biomedical journals, 17,000 patents, and 3,000 electrical research reports, (2) bibliographic database of European Community publications, (3) electronic publishing of patents, (4) electronic publishing of journals, e.g., *IDB (Informatics Daily Bulletin) On-line*, *The Electronic Magazine*, *Journal of Applied Chemistry*, electronic journals in chemistry, (5) electronic publishing of scientific, technical, and economic documents, (6) online retrieval and electronic distribution of scientific texts, and (7) network for informal exchange of information among university researchers in particular disciplines.

Hardware/software: The many partners under grant or contract pursued their own experiments, thus, hardware and software varied from experiment to experiment.

Sources: (Cawkell 1991, 64); (Mastroddi 1988, 122)

9.6 DocuTech

Product names: DocuTech

Years: 1990–

Principal institution: Xerox Corporation.

Objective: To create a printer with the ability to link into local networks or desktop-publishing workstations, to scan and store, transmit, manipulate images independently of documents. With additional attachments, DocuTech also binds and staples small booklets.

Hardware/software: DocuTech features: (1) 135 page-per-minute, 600 dot-per-inch laser printer with document scanning and processing ability; (2) automated booklet-making and document binding, (3) connectivity to local area networks, (4) compatibility with leading desktop-publishing packages and page description languages, (5) iconic user interface; (6) one gigabyte of internal storage.

Sources: (Varilla 1993); (Moad 1991, 79-80); (Smart 1993, 58)

9.7 Gateway to Information

Project name: Gateway to Information

Years: 1987–

Principal institution: The Ohio State University (OSU)

Partners: Department of Education, Fund for the Improvement of Post-Secondary Education.

Objective: To deploy a front-end to an online catalog and other information sources to teach students the following skills: (1) find, evaluate, and select materials that meet their needs regardless of format, (2) access and integrate CD/ROM-based databases, and (3) apply information-seeking and critical thinking skills with a high degree of independence.

Contents: (1) university library's online catalog, (2) CD/ROM-based encyclopedias, journal indexes, (3) on-screen instruction on search strategies, (4) on-screen information on print-based reference sources, (5) on-screen instruction on finding, evaluating, and selecting sources, (6) on-screen information on local facilities.

Hardware/software: Apple Macintosh II microcomputers, CD-NET servers on a local area network, campus data network, Hypercard, MacTCP, MitemView.

Sources: (Tiefel 1993); (Tiefel 1991)

9.8 IO+ Extended OPAC

Project name: IO+ Extended OPAC

Years: 1988–

Principal institution: University of Illinois at Urbana-Champaign (UIUC)

Partners: IBM Corporation, Council on Library Resources, Department of Education, University of Illinois General University.

Objective: To develop and test microcomputer software and hardware technologies to: (1) enhance the user-computer interface, (2) provide expert system searching techniques and guided assistance in user searching, (3) utilize multimedia technologies in providing assistance with user instruction and point-of-contact help, (4) provide extended access to information resources on the IO+ statewide network, and campus network, and the Internet, (5) explore document and image transmission in a campus-wide information system, and (6) provide enhanced access to periodical literature.

Contents: Access to local and remote information resources over several campus and national networks: (1) statewide ILLINET online catalog, (2) locally mounted mainframe-based BRS/Search retrieval system and several periodical indexes, e.g., Current Contents, ERIC, Reader's Guide, (3) database and telecommunications resources on the UIUC campus fiber-optic network, e.g., Oxford English Dictionary, weather, campus phone directory, (4) Internet resources, (5) locally-generated data files that can be customized by departmental libraries, (6) CD/ROM-based databases, and (7) capability of invoking specific commercial software packages.

Hardware: Client-server architecture, IBM/PS 2 microcomputers for workstations in university libraries.

Sources: (Mischo et al. 1990); (Mischo and Cole 1992).

9.9 Mann Library Gateway

Project name: Mann Library Gateway

Years: 1980s–

Principal institution: Mann Library, Cornell University.

Partners: National Agricultural Library, Apple Computer, Sony, BRS Information Technologies, BIOSIS, Pergamon Press, Research Libraries Group, Department of Education, Cornell Computer Services.

Objective: To create a prototype scholarly information system.

Contents: (1) BRS/Search accesses reference databases in agriculture, biology, business, education geology, e.g., Agricola, BIOSIS, ERIC, GeoRef, (2) tables of contents and references to articles (CARL's UnCover), (3) full-texts of 50 U.S. newspapers, (4) product information from the Dialog Business Connection, (5) data such as the 1990 census, climatological data, weather forecasts, (6) RLIN holdings, (7) Cornell's online catalog, (8) subject guide to Gateway resources.

Hardware/software: Client-server architecture.

Sources: (Olsen 1990, 222–7); (Barnes 1993, 12–15)

9.10 MemRI

Project name: Electronic Library Program of the Memex Research Institute (MemRI)

Years: Early 1990s–

Principal institution: Memex Research Institute, California State University.

Partners: Academic and public libraries such as the University of Maryland, IIT-Chicago Kent College of Law, San Diego State University, Atlanta-Fulton County Public Library, Broward County Public Library, corporate support from SilverPlatter, Apple Computer, INLEX, and Information on Demand.

Objective: To create large, publicly available indexed electronic image collections of published materials in academic, special, and public libraries.

Contents: (1) publicly available access information provided by catalogs, indexes in media ranging from CD/ROM to the library's online catalog; (2) imaged journal articles, book chapters, and other works; (3) access and delivery service on a local area network within an institution or through call-up services; (4) intellectual property management, a monitoring activity to track royalty.

Hardware: 386 IBM-compatible microcomputers, Fujitsu scanner, mini-jukebox configurations for optical storage.

Sources: (Butler 1991, 21–30)

9.11 MiteyBook

Project name: MiteyBook

Related project: SuperBook

Years: Late 1980s–

Principal institution: Bellcore

Objectives: Same as SuperBook with two additional objectives: (1) to accommodate potential SuperBook users who do not have workstations with large screens, (2) to accommodate users who do have large screens and who want to access documentation while devoting their screen primarily to other systems.

Contents: Same as SuperBook.

Hardware/software: Same as SuperBook but displays are limited to a grid of only 640 x 350 pixels (i.e., less than the number of pixels on many common PC screens operating with a standard graphics card).

Sources: (Egan et al. 1989b)

9.12 NCSU DDTP

Project name: North Carolina State University (NCSU) Digitized Document Transmission Project (DDTP)

Pilot project name: National Agricultural Text Digitizing Project (NATDP)

Years: 1986–

Principal institution: North Carolina State University Libraries.

Partners: National Agricultural Library, Apple Computer, several dozen landgrant university libraries, United States Department of Agriculture (USDA), Department of Education.

Pilot project objectives: To test the feasibility, cost, and effectiveness of newly emerging technologies for capturing bit-mapped page images and converting the images to ASCII text, providing software for access to their content, and disseminating texts to the agricultural community.

Pilot project contents: CD/ROM disks containing (1) 4,000 pages on aquaculture; (2) international research; (3) acid rain materials; (4) agent orange materials.

Objectives: (1) To explore and evaluate issues involved in implementing digitized document delivery to a large research community; (2) to establish libraries as stockholders in developing the national research and education network; (3) to examine issues related to selecting hardware platforms for delivering documents using network technology; (4) to disseminate the project results widely.

Contents: Library materials that researchers request through a library's interlibrary loan service are digitized and transmitted to requesting libraries via the Internet.

Hardware: (1) Mac IIsi with a minimum 80 MB hard drive, 8MB of RAM, (2) Abaton 300GS high-resolution scanner, (3) Apple NT PostScript laser printer (300 dpi), (4) Ethernet card, (5) Etherprint device, (6) host computer/network server at the recipient site.

Sources: (Casorso 1992, 271-273); (Eaton and Andre 1992, 19-20); (North Carolina State University 1991, 37-42); (Jackson 1993, 17-20)

9.13 Network Fax Project

Project name: Network Fax Project

Years: Early 1990s–

Principal institution: Ohio State University

Partners: CICNet, OARNet, ten libraries.

Objective: To develop an Internet-fax gateway that can be used with existing Group III fax machines.

Procedure: Requesters submit interlibrary loan requests through traditional loan messaging systems (e.g., OCLC or RLIN). Staff at the supplying library retrieve the journal, scan the requested article using a Group III fax machine, dial the PC fax number, and send the fax to the PC where it is stored on hard disk. The PC transmits the fax via the Internet where it is received at the requester's PC. The requester's PC dials the fax machine, faxes the article to the fax machine for printing.

Hardware: IBM-compatible platform, VGA monitors, ethernet cards, fax cards, two dedicated phone lines, Group III fax machine.

Source: (Jackson 1993)

9.14 OJCCT

Service name: Online Journal of Current Clinical Trials (OJCCT)

Earlier project: Graph-Text.

Years: 1989–

Partners: OCLC Online Computer Library Center, American Association for the Advancement of Science (AAAS).

Objective: To combine the immediacy of online technology with the high standards of the most prestigious research journals to create a high-caliber medical electronic journal.

Contents: Peer-reviewed medical journal focusing on clinical trials containing graphics and completely searchable full-text.

Hardware/software: Two interfaces available: (1) GUIDON, an OCLC-designed graphical user interface based on Microsoft Windows, needs the minimum of a 286 PC and a 9600 baud modem; and (2) an ASCII terminal, character-based interface, needs a VT190-type terminal or terminal emulator and modem combination. Access to OJCCT is available through OCLC, CompuServe, Internet, or OCLC's international telecommunications network.

Sources: (Keyhani 1993,14–19).

9.15 Primis

Project name: Primis

Years: 1989–

Principal institution: McGraw-Hill.

Partners: Eastman Kodak, R. R. Donnelley, hundreds of universities.

Objective: To allow faculty to combine selected textbook chapters, journal articles, case studies, course notes, and other educational materials into bound textbooks tailored to the needs of specific classes or students.

Contents: McGraw-Hill's texts and supplemental materials on business and economics, engineering, computer science, science, mathematics, social sciences, humanities, case studies, and articles from magazines and journals such as *Business Week* and *The Journal of Accountancy*.

Hardware/software: microcomputer hardware and software to search the Primis database; Primis software for textbook production.

Sources: (Dionne 1991); (Watkins 1991, A25).

9.16 Project Athena

Project name: Project Athena

Years: 1983–

Principal institution: Massachusetts Institute of Technology.

Partners: Digital Equipment Corporation, IBM.

Objective: To provide campus-wide, high-quality computing based on a large network of workstations and to incorporate modern computer technology into all levels of the educational process.

Hardware: 10 Network File System file servers, 24 Remote Virtual Disk file servers, 2 Andrew File System file servers, 70 Postscript printers, 3 name servers, 3 post office servers, and 2 authentication servers. Digital VAXstations and IBM PCs are supported. 25 multimedia workstations supporting full-motion color and video; forty gigabytes of disk storage in workstations and an additional fifty gigabytes in network file servers.

Source: (Champine, Greer, and Ruh 1990, 40).

9.17 Project Janus

Project name: Project Janus

Years: 1993–

Principal institution: Law Library, Columbia University.

Partners: Thinking Machines.

Objective: To utilize current technologies of digital full-text storage, searching, and retrieval to create a virtual library of the physical library collection, creating greater access and saving space.

Contents: (1) Julius and Ethel Rosenberg archive, (2) Nuremberg War Trials papers, (3) various government documents, e.g., United Nations Rio Conference on the Environment, North America Free Trade Agreement Treaty. Also, the Law Library plans to convert 10,000 to 12,000 volumes a year to computer storage by 1996.

Hardware: Connect Machine 2 which is a parallel supercomputer from Thinking Machines Corporation containing 32,000 processors, 256 megabytes of main memory, and 20 gigabytes of hard disk storage.

Sources: ("Virtual Libraries" 1993, 19); ("Virtual Library" 1993, 12)

9.18 Project Mercury

Project name: Project Mercury

Years: 1989–

Principal institution: Carnegie Mellon University.

Partners: OCLC Online Computer Library Center, Digital Equipment Corporation, Pew Memorial Trust, Apple Computer, American Association for Artificial Intelligence.

Objective: To build a prototype electronic library based on today's networking standards and information technology and to test the system with a real user population.

Contents: Phase I — over a dozen ASCII databases containing bibliographic citations linked to full texts on CD/ROMs, reference databases on CD/ROMs (e.g., *American Heritage Dictionary*, *Academic American Encyclopedia*), enhanced library catalog records. Phase II — documents in bit-mapped page format (from a pool of 27,000 pages from seven journals published by Elsevier and/or the Institute of Electrical and Electronics Engineers, possibly the Association for Computing Machinery and/or Pergamon).

Hardware: Personal computers with displays of 1,000 x 1,000 pixels, networks with speeds of 1M to 10M bits/second, magnetic disks, optical disks.

Sources: (Kibby and Evans 1989, 18); (Arms and Michalak 1990, 266-71); (Michalak and Troll 1992, 24-8); ("Virtual Libraries" 1993, 19)

9.19 Project QUARTET

Project name: Project QUARTET

Related project: Adonis

Earlier project: BLEND

Years: Mid 1980s.

Partners: British Library Research and Development Department (BLRRD), Loughborough University, Birmingham University, Hatfield Polytechnic, and University College London.

Objective: To investigate the applications of new technology to the improvement of communications within the United Kingdom academic research community, including mechanisms for publication, research dissemination, conferences and seminars. Different QUARTET sites explored different technologies, e.g., electronic mail, computer conferencing, online databases, and automated document delivery services (provided by Adonis).

Contents; Hardware/software: The four sites individually pursued their own investigations into particular areas of the technology of electronic communication, e.g., ergonomics of workstations, difficulties of reading screen-based text, idiosyncrasies of ISDN, handling large fax image databases, document delivery, etc.

Sources: (Tuck 1989)

9.20 Red Sage

Project name: Red Sage

Years: 1991–

Principal institution: University of California at San Francisco (UCSF)

Partner: Springer-Verlag, AT&T Bell Laboratories.

Objective: To explore the technical, economic, business, scientific, legal, and user issues surrounding scientific communication in a knowledge management environment.

Contents: Journals published by Springer-Verlag covering molecular biology, radiology, chemistry, *New England Journal of Medicine*, publications published by Wiley.

Equipment: Possibly, RightPages™, client-server architecture, Suns, Macs, XWindows, optical storage.

Sources: (Lucier 1992); ("Virtual Libraries" 1993, 18–19)

9.21 RightPages™

Project name: RightPages™

Years: 1990–

Earlier projects: LINUS, EXPRESS.

Principal institutions: AT&T Bell Laboratories Library Network and the Computing Systems Research Laboratory.

Partner: University of California at San Francisco (UCSF).

Objective: To create an electronic library that would preserve the look and feel of browsing in a physical library, deliver text and images to the workstation, alert users to articles published in their fields of interest, and act as a testbed for research in document analysis, user interfaces, multimedia databases, and electronic library usage.

Contents: At AT&T — 68 journals from 12 publishers covering the areas of artificial intelligence, computer-aided design, telecommunications, software engineering, computer graphics, computer science, man-machine interface, image processing, and telephony.

Hardware/software: (1) Local area network connected to scanning stations, (2) multiple workstations running XWindows servers, and (3) centralized document database server. The commercial version of RightPages™ should be compatible with three platforms: (1) AT&T's UNIX, (2) an already released Macintosh version, and (3) a soon-to-be-released version for Microsoft Windows.

Sources: (Hoffman, et al. 1993, 446); ("Virtual Libraries" 1993, 18–19)

9.22 SuperBook

Project name: SuperBook

Related project: Miteybook

Years: Late 1980s–

Principal institution: Bellcore

Objective: (1) To improve the usability of conventional documents, (2) to automate document processing by using a computer program to process the machine-readable version of a conventional document and transform it into a usable computer-delivered document.

Contents: Conventional documents that SuperBook could process into usable computer-delivered documents include single reference books, a small library arranged by topic, computer manuals, journal articles, or binders of technical documents.

Hardware/software: A SuperBook display configuration requires a Sun 3/75 workstation, running Bellcore's MGR window manager connected via ethernet to a file server that stores the preprocessed text.

Sources: (Egan et al. 1989a); (Egan et al. 1989b)

9.23 TULIP

Project name: TULIP (The University Licensing Program)

Years: 1991-1995.

Principal institution: Elsevier.

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Partners: To date, nine universities that have strengths in the physical and engineering sciences, such as Carnegie Mellon University, University of Michigan, Cornell University, Princeton University, and Georgia Institute of Technology, are TULIP participants.

Objectives: To test systems for networked delivery and use of journals and to strive: (1) to determine the technical feasibility of networked distribution to and across institutions with varying levels of sophistication in their technical infrastructure, (2) to reduce the unit cost of information delivery and retrieval, (3) to study reader usage patterns under different distribution situations.

Contents: Elsevier provides participating universities with electronic files on a bi-weekly basis for 43 Elsevier and Pergamon journals in materials science and engineering. As of August 1993, Elsevier had provided over 152,500 journal pages.

Hardware/software: The many universities involved in TULIP pursued their own development work. Although hardware and software vary from university to university, participants are sharing software design.

Sources: (TULIP updates 1993, nos. 1–2).

10 Libraries of the Future

This section features discussions of the library of the future: its mission, collections, administration, operations, services to users, training of staff, and facilities.

10.1 Mission statements

- "In order to increase the library's relevancy and its role in the present information environment, we must shift focus to include the following directions: (1) from library-centered to information centered, (2) from the library as an institution to the library as an information provider, and the librarians as a skilled information specialist functioning in an all-related information environment, (3) from using new technology for the automation of library functions to utilizing technology for the enhancement of information access not physically contained within the four walls of the library, and (4) from library networking for information provision to area networking for all types of information sources providers."

(Chen 1986, 263)

Here are mission and vision statements for the library of the future. They champion organizations that are responsive to change, play an active role in the formulation of information policy, foster collaborative activities, provide access to information located at remote sites, and complement technology-based access to information with a human component.

- A unified vision for the research library of the future does not yet exist. Visions range from the research library as an institution "bound to its historic mission of storing and organizing printed materials, too well adapted to its traditional niche and unable to evolve quickly enough, [that] will have to adjust to a diminished role in the future if it survives the transition at all" to the research library as "an organic, adaptive institution, capable of riding the forces of change to emerge as a leader in networked information services."

  (Sutton 1992, 2)

- "Future mission of the research library will be: to ensure that a ready and free flow of information-based services, collections, and library services are integrated into the research, teaching, and administrative functions of the university. To pursue this mission the library must assume a central and integral role in formulating policy, and in fostering collaborative activities within the university and with other actors in the scholarly communication process."

  (Woodsworth et al. 1989, 132)

- "Libraries are failing because they are tied inexorably to the past. They are failing because they are a design of the conventional wisdom and so reinforce their values and their stale ritual without questions, without remorse. They fail because they are morally and psychologically bound to the physical plan and to the physical objects, rather than to clients, and to problem solving ... It is very difficult, it may be impossible, for a conventional, passive, and complacent professional discipline to break dramatically with the past ... This is necessary if librarianship is to survive as anything other than a custodial function."

  (Wasserman cited by Hirshon 1993b, v)

- "The vision is simply stated: that we create a universal window to the vast array of information held by our libraries and that this window be offered to the widest possible audience. In other words, we must work to make what we have *accessible* and to *communicate* the wealth of information in our libraries."

  (Penniman 1992a, 24)

10.2 Collections

Measuring the value of library collections:

Writers criticize the current method of evaluating libraries on the basis of collection size, depth, or breadth, and urge accrediting organizations to develop new measures or criteria that are in sync with new models of networked information.

- The value of the library of the future will not be measured by the size, depth, or breadth of the collections owned.

  Supporting: (Woodsworth et al. 1989, 134); (Peters 1992, 57); (Mason 1985, 137); (Dougherty and Hughes 1991, 12); (Dougherty and Hughes 1993, 12); (White 1990, 54); (Dougherty 1991, 60)

- "If ARL [Association of Research Libraries] does not change its approach, some other group will develop its own mechanism to measure the value of research information resources."

  (Metz 1990, 30)

- "The alternative philosophy is that every information service or product has a measurable value ... This approach to measuring value (as well as cost) has serious implications for the infrastructure of a library ... It positions the library as a delivery mechanism rather than a warehouse with an emphasis on output, not assets."

  (Penniman 1992b, 42)

- "Individual libraries may be evaluated, not just on the strength of their own holdings, but on the robustness and accessibility of their interconnections with other sites."

  (Basch 1991, 22)

Future collections:

- " ... A library should not try to 'do it all' but rather should focus on those materials and issues which are most central to the basic needs and roles of our colleges and universities, particularly the basic research materials of our libraries."

  (Hawkins 1993, 12)

- Collection budgets will gradually reflect the transfer from predemand stockpiling to on-demand delivery.

  Supporting: (Hacken 1988, 488); (DeBuse 1988, 14)

- "Collection self-sufficiency is still the dominant operational philosophy of most research universities, even in the face of certain and severe financial constraints."

  (Dougherty and Hughes 1991, 6)

- " ... Every university will have to maintain basic collections for teaching and research, as well as to accept responsibility for building depth in focused areas of the collections. But we ought to envision a time when the autonomous individual collections of our nation's research libraries are in substantial degree melded into a large dispersed collection to which we all contribute and in which we all share equally, with appropriate allowances for our respective needs and investments."

  (Frye 1990, 11)

- "Once the bulk of intellectual matter is in electronic formats, giving a computer to a student and paying for access to applicable online and static information services will cost less than continuing to operate and stock the classic campus or public library."

  (Kountz 1992, 40)

The statements listed here discuss library collections of the future. Elements of some statements reinforce values associated with paper-based collections.

10.3 Library administration

Leadership:

- "Libraries are in jeopardy because we do not have enough visionary leadership. Visionary leaders differ from visionaries. A visionary may be able to describe a desired future. A visionary leader is able to describe the desired future and is also able to make that future happen with the help of others. A visionary leader is a change agent of the highest order."

  (Penniman 1992b, 40)

- "Library administrators have the responsibility to create organizational climates that encourage and promote change."

  (Lucier and Dooley 1985, 47)

- "The library should develop a strong proprietary/cooperative role toward new forms of information systems as these systems emerge. If it is a medium that has to do with knowledge or even 'mere information,' the library ought to be there ready and waiting to take it over."

  (Hendrick 1986, 130)

- Library administrators will spend "more time and effort on interinstitutional cooperation, consortia, and nationally coordinated efforts, as well as external development of information policies at regional, national, and international levels" and will "participate to a greater extent in the development of information policy on campus."

  (Woodsworth et al. 1989, 135)

The library of the future requires visionary leaders who not only describe a desired future but who can mobilize and work with others to bring it about.

Organizational structures:

- Staff will be deployed as needed in service clusters that cut across information handling, access system design, and delivery service lines. Group affiliation will range from very short term to semi-permanent with some support centrally based.

  (Woodsworth et al. 1989, 135)

- "The use of a project-team approach to information problems will be a common practice in the future. Since many reference librarians will be specialists to a degree unheard of at the present time, the use of the project team will be essential to increase both the scope and the accuracy of information services."

  (Surprenant and Perry-Holmes 1985, 237)

  Also supporting: (Dougherty and Hughes 1991, 11); (Rochell 1987, 47)

- "Libraries will need structures which allow for increased flexibility and innovation and which are more responsible to change than at present ... Rise of new, networked organizations that are flatter and less centralized."

  (Von Wahlde and Schiller 1993, 16)

In the library of the future, organizational structures will be flatter than those of traditional libraries. Staff may no longer be permanently connected with a particular department based on library operations or functions. Instead they could be assigned to service clusters or project teams to accomplish particular tasks or provide customized service.

10.4 Library operations

10.4.1 Deinstitutionalizing the profession

- (Question asked rhetorically) "Do the major values and insights of the field have to be defined by the building in which most of us work? Do our texts in the field have to portray librarians in terms of this building, instead of in terms of the knowledge, attitudes, and skills needed to provide information services in a wide variety of settings, including libraries?"

  (Du Mont 1988, 17)

In the library of the future, librarians will no longer need to be physically inside a particular building or posted near a collection because information resources will be distributed across the network and available to information seekers through network capabilities.

- "The process of de-institutionalization will accelerate very dramatically in the next few years. The fact is that computer and telecommunications technologies are making it increasingly feasible for librarians to perform their professional tasks outside of the library."

  (Lancaster 1983, 748)

In academic environments, it will make more sense to deploy librarians in schools and departments where they can learn about the culture of students, faculty, and researchers, and enrich it through the development and deployment informational tools for network navigation that are specific to the teaching and research activities of their particular unit.

- "Libraries as localized collections of physical materials will cease to exist, and librarianship will evolve into a more distributed profession, with practitioners working within user organizations rather than libraries, and possibly working more as free-lance information specialists."

  (Ochai 1984, 371)

- "It may be that the scenario envisioned by F. W. Lancaster, in which many librarians become deinstitutionalized in terms of their relationship to the resources providing the basis for their information services, will prove true for a substantial number of our profession. The physical location of collections will become more and more immaterial. Working with scholars or business people to facilitate customized packaging of information resources available via their own workstations could become a significant element of library services."

  (Horny 1987, 9)

Future public libraries will also feature a distributed network of librarians who resemble today's information brokers. Public librarians may work directly from their homes where they are posted on the information network to handle inquiries about network use from users in the community. They may also work in local government, public service organizations, referral centers, malls and shopping centers where they can learn first-hand about the needs of their constituents. This contact will enable them to tailor their development of specialized informational tools such as information kiosks to community needs.

- "There will be many fewer libraries and many fewer librarians associated with them, who will stay as information specialists in collection development, database maintenance, information input, and searching. The remainder of librarians will be cast out of the electronic library building to assume new roles in an information-rich society."

  (Seiler and Surprenant 1991, 31)

10.4.2 Collection development

- "Interlibrary loan and acquisition functions will merge as materials are requested directly through a computer terminal."

  (Hacken 1988, 491)

- "In acquisitions, people will be negotiating licenses instead of ordering books."

  (Dowlin 1991, 320)

- " ... Collection development staff will move toward being database access specialists."

  (Hacken 1988, 491)

In the future, collections development staff will have instantaneous access to new artifacts. For example, approval plans will allow staff to download potential new works for close inspection. Their evaluation might include an assessment of the number and quality of relationships with artifacts in the existing digital collection.

- "Libraries that formerly had more than one librarian working in acquisitions will experience a shift to paraprofessionals. The whole order process will be handled electronically between highly trained order clerks and the collection management/development librarian."

  (Alley 1990, 576)

Collections development staff will negotiate and maintain artifact licenses with publishers. They will also survey networked information, locate and evaluate public domain artifacts, and query their creators about their volatility.

10.4.3 Resource sharing

- "But for information in electronic form, interlibrary loan is usually impossible. The electronic information a library acquires is typically *licensed* rather than purchased, and the library's subsequent use of that material is governed by the contract that it signed with the publisher rather than by copyright law. The contract is likely to be more restrictive than the copyright law and to forbid any exchange of the material through interlibrary loan."

  (Lynch 1993, 13)

- "Efficient methods of resource sharing will remain vital for older, printed materials, but are likely to be quite problematic where electronic media are concerned ... What costs and rights are involved in sharing library investments in these resources?"

  (Horny 1987, 8)

Two different points of view are given on resource sharing. Some writers feel resource sharing will be given high priority in the library of the future. Other writers feel resource sharing will be a moot point in digital library environments because artifact licensing will prohibit it. Resource sharing will remain a vital operation in digital libraries governed by the noncommercial publishing model. However, it could disappear in libraries governed by the acquisition-on-demand model because of restrictions in licensing agreements.

- "From my point of view, the problem is not so much with the volume of interlibrary loan activity as with the very low priority we give to resource sharing in our libraries."

  (Branin 1992, 327)

- "Cooperation and resource sharing are to some degree unnatural acts in the highly competitive sphere of higher education. The type of statewide cooperation required for effective joint acquisitions and resource sharing is out of sync with most other higher education endeavors. Typically, neither the campus nor the state reward such activities, and frequently cooperative efforts elicit a great deal of suspicion among campus officers, for network autonomy in decision-making requires that libraries give up some local autonomy in decision-making and management and sacrifice some budgetary flexibility. Neither accreditation standards nor funding mechanisms foster cooperative activities."

  (Breivik and Gee 1989, 138)

- "Universities will have to work together to create a series of regional and national resources centers to assure that scholarly resources are acquired and preserved."

  (Lewis 1988, 302)

- "Resource sharing is no longer an option. It is a vital necessity."

  (Breivik and Gee 1989, 139)

10.4.4 Circulation

- " ... Circulation personnel will move toward being database usage controllers (regulating delivery, copyright, restrictions and so forth)."

  (Hacken 1988, 491)

- "Future library circulation and other services will be almost totally automated and self-service provided, as in today's automatic teller machines."

  (Hennen 1988, 392)

  Also supporting: (Alley 1990, 577–8)

Under the acquisition-on-demand model of the library of the future, borrowing digital materials will be tantamount to owning them. Thus library circulation staff in the library of the future will become copyright compliance personnel who make sure transactions between libraries and users do not violate copyright law or licensing agreements.

10.4.5 Cataloging

- "In ten more years, as technology evolves still further, direct retrieval of text and image will be standard practice, and cataloging as we know it will be largely a thing of the past."

  (Blair 1992, 72)

- "As in-house technical processing recedes into the afterglow of shared-cataloging nirvana, catalogers and other technical processing staff will move toward being managers — rather than producers — of online records."

  (Hacken 1988, 491)

- "Many routine operations will be handled by external contractors."

  (Woodsworth et al. 1989, 135)

- "Cataloging may not take place entirely within libraries. Publishers of electronic manuscripts may have their own staffs provide standardized bibliographic records with a variety of subject access points."

  (Horny 1987, 8)

In the future, digital artifacts will be encoded in standard ways that lend themselves to automatic descriptive cataloging.

There will be a bright future for subject catalogers who can break away from traditional subject cataloging tools and models. They will devise new organizational tools to describe the intellectual contents of digital library materials and establish links between them. These tools will be applied to digital artifacts that vary in depth (e.g., digital books, journals, and forms that have not yet been invented), they will support an encyclopedic array of disciplines, and they will serve information seekers who range from novices to scholars in their knowledge of a particular subject area.

10.4.6 Reference work

Deinstitutionalization:

- "Vast majority of reference librarians will be in service-point offices, outside of the library, where they can be close to the action in their user community. Electronic hookups will tie these reference librarians to the host library."

  (Surprenant and Perry-Holmes 1985, 236)

  Also supporting: (Lancaster 1983, 751)

- "The itinerant librarian will go directly to clients on site."

  (Surprenant and Perry-Holmes 1985, 236)

- " ... Specialists will tend to be dispersed in the community and the generalists stationed at the main library — organizing teams, identifying and coordinating information needs, and helping with access to the telecommunications grid."

  (Surprenant and Perry-Holmes 1985, 237)

Descriptions of future reference librarians focus on deinstitutionalization. Information technologies will free reference librarians from postings in particular places. They will interact directly with people who have information needs or use technologies to facilitate the interaction. Conversely information technologies will free end users from visiting particular places to obtain assistance in satisfying their information needs.

Human dimension of librarianship:

- "No technology can beat the highly developed skill of a librarian who can analyze an information problem, figure out the real underlying questions, and match those questions with answers. No machine can compete with a creative, knowledgeable, flexible professional librarian, one who provides interpersonal interaction, information evaluation, communication, synthesis, and judgment ... Our challenge is to help people formulate the right questions.""

  (Schuman 1990, 38)

  Also supporting: (Du Mont 1988, 18); (Horny 1987, 11); (Lancaster 1983, 750)

Many writers feel the library of the future should not ignore the human dimension of librarianship. Here are a few characteristic discussions describing this human dimension.

- "Until such time as computers are capable of matching our intelligence, the role of humans in the process of managing and imparting knowledge will remain central."

  (Kurzweil 1993, 55)

- Librarians "are a labor-intensive, helping profession and should do everything necessary to protect and extend these important values."

  (Surprenant and Perry-Holmes 1985, 235)

Personalizing information:

- "The goals are to make information easy to find and obtain, add value to the customer's performance of her/his work, and make a positive difference in customer well-being."

  (Drake 1990a, 7)

- "The work of the knowledge counselor will be much more intellectual, requiring much more skill at selecting, analyzing, and synthesizing information. It will be much broader, and it will be more rewarding to society."

  (Spaulding 1988, 89)

- "The librarian in the information age will be crucially vested in personalizing information and providing knowledge in the context of the recipient's interests."

  (Murr and Williams 1987, 11)

Writers frequently discuss how librarians "add value" to information. In the context of reference work in the library of the future, selections describe how librarians "personalize" information.

The authors found so many writers who discuss how librarians personalize information that they felt compelled to include many selections in this section.

- Librarians add value "by organizing, selecting, and refining the commercial offerings ... by organizing and integrating the fragmented information access environment ... by searching and evaluating information that is becoming complex and difficult to find. (If librarians don't do this, enterprising librarians will leave the library, do it for users, and compete with libraries.)"

  (Lynch 1992a, 30, 35–36)

  Also supporting: (Riggs cited by Riggs and Sabine 1988, 190)

- Librarians will act as information or reader advisors letting technology and expert systems answer the basic questions and helping users evaluate and shape their searches, telling users what the best sources are, most economic sources, etc.

  (Farber cited by Riggs and Sabine 1988, 6, 24)

  Also supporting: (Rosenthal cited by Riggs and Sabine 1988, 6–7)

- "When everyone is plugged in, the librarian becomes the 'gateway' ... Presently, there are so many gateways, that one needs a gateway to the gateways. This is the librarian's job — to interpret the means of access ... The gateway librarian, who advises on the best route to information and interprets the language of access, will have job security for years to come."

  (Anders, Cook, and Pitts 1992, 40)

- "As a result of the chaos, users will need expert advice and assistance in order to make effective use of sources and services."

  (Malinconico 1992, 40)

- Librarians will aid users in articulating a request, choosing appropriate databases, representing their information needs in the appropriate vocabulary, interpreting results, improving information literacy.

  (Wegner 1992, 89)

- Librarians will provide instruction to ensure information literacy and knowledge of technology.

  Supporting: (Woodsworth et al. 1989, 134); (Olsen 1990, 230); (Moffett cited in "Librarian's job" 1990, 19); (John cited in "Librarian's job" 1990, 19); (Young 1989, 9-10); (Murr and Williams 1987, 11); (Dougherty and Hughes 1993, 11); (Rochell 1987, 47); (Wegner 1992, 88)

- Librarians will take an increasingly proactive role in advising individuals, departments, and groups on how and where to access electronic information.

  Supporting: (Woodsworth et al. 1989, 135); (Woodsworth and Hoffmann 1988, 93); (Dougherty cited in "Librarian's job" 1990, 18, 19); (Young 1989, 9); (Dunstan 1986, 6); (Rice 1986, 19); (Cargill 1992, 83)

- Librarians will advise users on how to find the information they need, assist them in learning how to navigate cyberspace, and in interpreting the results.

  Supporting: (Beiser 1992, 26); (Dougherty and Hughes 1993, 11); (Lancaster 1983, 750)

- "They [librarians] will need to function more like consulting information engineers than traditional, passive information resource custodians and dispensers of documents."

  (Malinconico cited by "Will computers render" 1992, 565)

  Also supporting: (Lancaster 1983, 750)

- "Librarians ... will have to learn to handle long-distance users — library patrons they have never seen."

  (Moran 1989, 39)

10.5 New user services

Various new services:

- "Librarians would engage instead in developing the new systems and services of the virtual library, such as gateways, user interfaces, search and retrieval systems, tools for navigating the networks, and document delivery systems."

  (Von Wahlde and Schiller 1993, 23)

- Librarians will plan, design, and develop databases and other digital productions for both individuals and groups of users.

  Supporting: (Woodsworth et al. 1989, 134); (Kibby and Evans 1989, 20); (Berger cited in Riggs and Sabine 1988, 2); (Long cited in "Librarian's job" 1990, 19); (Dunstan 1986, 6); (Lancaster 1983, 750); (Dougherty and Hughes 1993, 9, 11)

- "School librarians are going to become much more actively involved with teachers in the instructional process."

  (Whitney cited by Riggs and Sabine 1988, 1)

- Librarians will plan and design electronic publications, design and operate electronic networks, organize electronic information files, devise and implement new types of information services, and keep clients aware of newly available information sources.

  (Lancaster 1983, 750)

- " ... Librarians will become hypertext engineers ... They will provide intellectual connections between the works of different authors or convert linear publications to hypermedia publications."

  (DeBuse 1988, 17)

  Also supporting: (Murr and Williams 1987, 15)

Many new services are connected with organizing networked information, making improvements to network capabilities, and devising informational tools to enable end users to utilize information networks in the pursuit of knowledge.

Examples are designing and developing information kiosks, archiving digital resources, and transforming digital resources into formats that can be accessed on the equipment of the day.

- Librarians will archive out-dated software to use with the journals or convert archived files to formats that can be used with current software.

  Supporting: (Langschied cited by "The impact of electronic journals" 1991, 187); (Piternick 1991, 27)

- "Can we rely on the information industry to preserve access to specialized or historical data that is no longer deemed economically viable? I doubt it. Does this imply ever greater roles for libraries and library consortia or utilities in regaining control over specialized and scholarly databases and database back files that the information industry will not support? I think so."

  (Lowry 1993, 70–1)

  Also supporting: (Yavarkovsky 1990, 15); (Langschied cited by "The impact of electronic journals" 1991, 187); (Piternick 1991, 27); (Ginsburg 1993, 60)

- Librarians will design and develop public kiosk "microlibrary" service that provides search services and image document delivery on demand.

  (Butler 1991, 28)

- "[Librarians will develop] online guides that will, upon indicating a subject area of the patron's interest: (1) direct the patron to which tools will possibly have the answers — in priority of likelihood, (2) proceed to provide a quick guide to instructions that will make it easier for the patron to use each tool, and (3) allow the patron to input the subject and access the citations needed, moving from database to database without reconstructing the search strategy.

  (Cargill 1992, 83)

- Librarians could develop expert systems to provide reference assistance to users when reference staff are not available or nearby, to capture knowledge of staff subject specialists when they are not available, to accommodate many users at the same time, to provide bibliographic instruction.

  Supporting: (Riggs cited by Riggs and Sabine 1988, 188); (Cargill 1992, 84); (Murr and Williams 1987, 17)

New responsibilities:

New services will require new and expanded responsibilities.

- Librarians will evaluate information products, formats, platforms, delivery systems, and media.

  (Ray 1993, 49)

- If they want to hold positions of authority in the future, librarians must take responsibility for providing real information and vouching for its correctness.

  Supporting: Fayen (1986, 241); (Lynch 1992a, 35); (Regan 1987, 297); (Woodsworth et al. 1989, 134); (Lancaster 1983, 750); (Rice 1986, 19)

- Librarians will engage in strategic planning to articulate their mission, goals, objectives, and service roles in a networked environment, and to clearly establish priorities. To be effective, strategic planning must take place within the context of the strategic directions of the parent organization."

  Supporting: (Von Wahlde and Schiller 1993, 26); (Woodsworth et al. 1989, 134); (Long cited in "Librarian's job" 1990, 19)

- " ... The library community itself must proactively identify and adopt new and changing responsibilities. Librarians cannot wait for permission to change what they are doing."

  (Dougherty and Hughes 1991, 13)

Providing services at cost:

- "The general availability and value of information as a commodity will influence libraries to sell information systems and access, package information for the academic market, and, possibly for the general public."

  (Woodsworth et al. 1989, 136)

- Librarians will provide networked information to business and industry (especially small businesses that have neither the time nor staff to obtain needed information) at a cost.

  Supporting: (Rush 1992, 78); (Mason cited by Riggs and Sabine 1988, 14); (Mason 1985, 139); (Long cited in "Librarian's job" 1990, 19); (Hendrick 1986, 130); (Malinconico 1992, 40)

- Librarians will work with others in the institution to make locally-created databases commercially available beyond the university.

  (Woodsworth et al. 1989, 134)

Several writers call for marketing library services to business and industry. Librarians could market locally-created databases. They are also sitting on a gold mine of unique library resources — archival materials, original manuscripts, artifacts — that they could organize, repackage into integrated media productions, and market beyond their constituencies.

Charging for services issues:

- The philosophy of keeping library services and collections as free goods is at risk.

  Supporting: (Woodsworth et al. 1989, 136); (Gapen cited by Saunders 1992b, 67); (Gapen 1993, 2); (Mason 1985, 138); (Hoadley 1986, 23); (Surprenant and Perry-Holmes 1985, 235); (Von Wahlde and Schiller 1993, 321); (Woodsworth and Hoffmann 1988, 97)

- Research librarians have to assume leadership in facing the "fee or free" issues that are emerging ... Librarians should give up their "platitudes" and "illusions that information is free."

  (Dougherty and Hughes 1991, 9)

- "Should new services, including new information technologies, and especially customized/tailored services, be funded by users/departments and be developed as self-supporting services?"

  (Woodsworth et al. 1989, 136)

- "If we allowed ourselves to shift to a mechanism of charging users, we not only disturb research strategies, promote ignorance, and disempower users, we also would incur the inefficiencies 'chargeback' which have haunted computer centers on our campuses for several decades. Computer centers discovered that assessing user fees method expends considerable resources on accounting structures to control access, thus reducing the slice of the pie that can be provided to basic services."

  (Hawkins 1993, 11)

"Fee versus free" has been a long-time issue in library literature. Several writers feel that charging for services is inevitable in the face of digital library models such as acquisition-on-demand. John Garrett reminds us of the resources that computer centers required to track usage and advises librarians to find alternatives to such tracking. Clifford Lynch suggests the establishment of service tiers that feature charging for particular service levels.

"Fee versus free" issues will require considerable thinking and rethinking. They should be an important component of digital library projects to assess their impact on various end user communities.

- "Passing some part of the costs for information access back to the user is a natural outgrowth of existing document delivery services and acquisition-on-demand ... It opens the library up to competition, particularly in a networked environment where geography is largely irrelevant and any organization can compete for customers anywhere ... It is logical to shop the network for better and cheaper services ... We will undoubtedly see libraries develop multiple service tiers: a basic level free to all patrons, and one or more extra-cost service levels."

  (Lynch 1993, 13)

- "It is no longer a question of *if* fees should be charged, but rather when and how much."

  (Crismond cited by Hennen 1988, 391)

Returning to a simple past:

- "Preserve books as artifacts ... we will return to our true vocation, the most useful function we can perform — the preservation of the historical record, both for our contemporaries and for those who come after us ... Books are beautiful. They deserve to be preserved for this reason alone ... Our role models will be the archivists and rare books librarians ... Our twenty-first century patrons won't need us to be high-powered computer consultants. They will need us to maintain and preserve our book collections."

  (Westbrook 1992, 295)

- "The kinds of services I see developing are extensions of what we have been doing in the past and what we're doing right now. I don't foresee a great revolution ... I see more of an evolutionary process."

  (Mason cited by Riggs and Sabine 1988, 13)

Some writers view the library of the future as an extension of the library of the past and do not feel that librarians will be doing things differently from what they do today.

10.6 New skills, competencies, and knowledge for the future

Skills, competencies, and knowledge:

- "For the virtual library to become a reality, computer and networking skills will have to be more generally distributed throughout the organization. It will no longer be sufficient to have on board a small group of technical experts. All library staff will use or access computer resources as part of their daily tasks, possibly at their own workstations. And it will not be enough simply to train people in a set of technical skills."

  (Von Wahlde and Schiller 1993, 21)

- "Librarians possess certain skills, by virtue of their training and experience, that will remain critical to the organization, classification, and dissemination of knowledge. But they will have to develop additional skills and capabilities, and a willingness to accept and handle new technologies in order to assume important roles in the future."

  (Wall 1986, 38)

- Well-developed interpersonal skills.

  Supporting: (Woodsworth et al. 1989, 134); (Moffett cited in "Librarian's job" 1990, 19); (Dougherty 1991, 61)

- Knowledge of cognitive and disciplinary research processes.

  (Woodsworth et al. 1989, 134)

- Knowledge of psychology.

  (Woodsworth et al. 1989, 134)

- Technological sophistication.

  Supporting: (Woodsworth et al. 1989, 134); (Shaffer cited in "Librarian's job" 1990, 19); (Kelinson cited in "Librarian's job" 1990, 19); (Regan 1987, 296)

- Knowledge of information policy development and analysis.

  Supporting: (Woodsworth et al. 1989, 134); (Dougherty 1991, 61)

Not only will skills and knowledge of technology be important to the librarians of the future, they will need to enhance their knowledge and develop new skills to work with individuals and groups in various disciplines and to handle intellectual property issues.

- Synthesizing capabilities.

  Supporting: (Woodsworth et al. 1989, 135); (Long cited in "Librarian's job" 1990, 19)

- Ability to understand and articulate librarian roles in the organizations in which they function.

  (John cited in "Librarian's job" 1990, 19)

- Skills and sensitivity to work effectively with diverse cultural and ethnic groups.

  (Shaffer cited in "Librarian's job" 1990, 19)

- Greater management skills such as financial and strategic planning.

  (Dougherty 1991, 61)

- Visual communication skills.

  (Mason cited by Riggs and Sabine 1988, 20)

Personal characteristics:

Writers suggest that librarians of the future develop personal characteristics that will enable them to function effectively in environments of constant change.

- Political acumen.

  Supporting: (Woodsworth et al. 1989, 135); (Long cited in "Librarian's job" 1990, 19); (Dougherty 1991, 61)

- Assertiveness.

  (Woodsworth et al. 1989, 135)

- Risk-taking.

  Supporting: (Woodsworth et al. 1989, 135); (Dougherty and Hughes 1991, 13)

- Better activists.

  (Billings 1991b, 11)

- Ability to function in an atmosphere of ambiguity.

  (Woodsworth et al. 1989, 135)

- Ability to adopt the idea of continual change as a goal and mode of both personal and organizational operation.

  Supporting: (Lucier and Dooley 1985, 47); (Woodsworth et al. 1989, 135); (Dunstan 1986, 6); (Von Wahlde and Schiller 1993, 21)

10.7 Role of library schools

In the course of reviewing library of the future literature, the authors found calls for restructuring library school curricula and suggestions for improving their contents. This section features suggested improvements to library education to prepare professionals for the library of the future. It is based only on suggestions from "library of the future" literature; it is not based on a comprehensive review of "library education of the future" literature.

Here are listed calls for restructuring library school curricula.

Calls for restructuring curricula:

- "A massive overhaul of library school curricula will be needed if these institutions are to produce graduates who can contribute to and thrive in a changed world."

  (Lynch 1992b, 37)

- (Discussing the breach between information science and traditional library education, the author raises the rhetorical question:) "Does one kind of information-oriented curriculum have to exclude the other?"

  (Du Mont 1988, 17)

- "Continue restructuring of the curriculum ... Restructuring should involve the elimination of some current courses. Chief targets would be the courses devoted to specific sources and tools. Emphasis should shift to understanding the structure of various disciplines and how information is generated, organized, and used within them."

  (Woodsworth and Lester 1991, 208)

- "To prepare today's librarians for their role in the next few years, however, will require some rather substantial changes in our professional education, with the focus shifting from the library as an institution to the librarian as a skilled information specialist and facilitator of communication, capable of performing in many different environments, say, as an integral member of a research team or operating in a freelance capacity."

  (Lancaster 1985, 554)

- "Accrediting agencies must bless, even encourage, new directions and experiments in library education, such as affiliations with departments of engineering or computer science, and libraries must employ those recent library school graduates who have bold new ideas or a nontraditional array of courses ... We must rethink library education."

  (Campbell 1993, 564)

- "Electronic mail (Email), Gopher, and OPACs are all beneficial, but the future role of ILS [information and library studies] schools/programs and ILS professionals should be explored in relationship to a much broader segment of this vision space. A vision space which includes digital libraries (broadly defined), electronic communities, global information access through public libraries, and the emerging concept of knowledge-based systems and collaboratories."

  (Atkins 1993, 2)

How practitioners can help:

- "Adopt an attitude of partnership with library schools and responsibility for the preparation of librarians through (1) the redesign of library education and the creation of alternatives, (2) the provision of more in-house training and education, and (3) increased practitioner interaction with library educators."

  (Woodsworth et al. 1989, 138)

- "Actively recruit 'the brightest and best' into the library and information science profession."

  (Woodsworth et al. 1989, 138)

- "The ILS [information and library studies] schools must take the leadership in empowering the profession to maintain its vitality, influence, and relevance as we move into the world of digital libraries, the collaboratory, and knowledge management institutions. They must be strongly and tangibly supported by the leaders of the library profession and others with vested interest in the future of information access by society."

  (Atkins 1993, 5)

- As alumni and employers, we need to speak up for, and support, changes in library school education.

  (Regan 1987, 296)

- Revise attitudes of both the education and practicing sectors of the profession, e.g., focus on basic principles, theory, foundations, not on details of cataloging tools or commercial retrieval systems.

  (Woodsworth and Lester 1991, 208)

Here are some ideas on how library practitioners can help library schools in the restructuring process. They should start by demanding that library school curricula focus on basic principles, theory, and foundations, not on the development of skills or knowledge of specific tools or systems.

Curriculum content:

- Focus on technology.

  Supporting: (Chisholm cited by Riggs and Sabine 1988, 53); (Farber cited by Riggs and Sabine 1988, 54); (Heim cited by Riggs and Sabine 1988, 54); (McDonald cited by Riggs and Sabine 1988, 72); (Summers cited by Riggs and Sabine 1988, 67); (Stepanian cited by Riggs and Sabine 1988, 70); (Lancaster 1983, 753); (Vasilakis cited by Riggs and Sabine 1988, 68); (Asp cited by Riggs and Sabine 1988, 69); (Dowlin 1991, 320); (Rosenthal cited by Riggs and Sabine 1988, 70); (Dumont cited by Riggs and Sabine 1988, 73); (Lynch 1992b, 37)

- "The core of knowledge, skill, and practice for ILS [information and library studies] is the *intersection* of the understanding

1. of users and use of information (who and what they need and want, and how to find out);
2. of systems and services to provide intellectual and physical access to information and to make it available over long periods of time; and
3. of the underlying technology to support 1 and 2.

   ILS professionals (researchers and practitioners) need competencies in each of these areas, in the three overlaps between each area, and in the overlap of all three."

   (Atkins 1993, 4)

- "This curriculum must include a comprehensive coverage of the various technologies fueling the revolution — advanced user interfaces, mass media, computer networks, and database technology. It must include study of the exploration and uses of information resources, which needs to be coupled with study of information organization and use, but from a perspective founded more on basic theory than on the mechanics of today's practices."

  (Lynch 1992b, 37)

There is overwhelming agreement on expanding library school curricula to include technology. Some selections in this section also call for replacing the teaching of tools and mechanics of library practices with teaching theory and general principles.

- " ... Schools need to create the learning and research environments which will produce the 'digital library architects' who have the competence and personal traits to provide leadership of the multi-disciplinary teams who can design and build the digital library environments of the future. These would be extraordinary people with solid grounding in the values and current practice in librarianship; competence in related legal, economic, cognitive, and social issues; and design knowledge about digital information and collaboration systems."

  (Atkins 1993, 5)

- Database creation.

  (Dowlin 1991, 320)

- Focus on video.

  (Stepanian cited by Riggs and Sabine 1988, 70)

- Focus on cognitive sciences to understand how people learn.

  Supporting: (Farber cited by Riggs and Sabine 1988, 54); (Riggs cited by Riggs and Sabine 1988, 185–6)

- Make students better managers.

  Supporting: (Chisholm cited by Riggs and Sabine 1988, 53); (Wedgeworth cited by Riggs and Sabine 188, 56); (Eastman cited by Riggs and Sabine 1988, 57); (McDonald cited by Riggs and Sabine 1988, 72); (Strong cited by Riggs and Sabine 1988, 74)

- "Our preoccupation [with management sciences] should decline in the future. After all, there may not be many libraries around to be managed."

  (Lancaster 1983, 753)

- Focus on subspecialties within librarianship, e.g., school media, medical librarianship.

  (Summers cited by Riggs and Sabine 1988, 55)

- Teach catalog design architecture.

  Supporting: (Eagle 1992, 101); (Dowlin 1991, 320)

- Human communication: from the creation of recorded knowledge, its distribution, processing by various agencies, to its eventual assimilation and application.

  (Lancaster 1983, 752)

- Train students in cultural differences.

  (Smith cited by Riggs and Sabine 1988, 74)

- Create graduates that have a vision of the future.

  Supporting: (Strong cited by Riggs and Sabine 1988, 74–5); (McDonald cited by Riggs and Sabine 1988, 71)

Program requirements:

Several different suggestions on program requirements are given.

- Attract students from science, math, or computer science backgrounds.

  (Chisholm cited by Riggs and Sabine 1988, 53)

- "A significant part of their education must involve participation in realistic pilot projects which force consideration of the system in the large — human (individual and organizational) and technical issues."

  (Atkins 1993, 5)

- Lengthen programs by instituting residencies and the development of specific expertise in the field.

  (Woodsworth and Lester 1991, 208)

- Feature double or joint master's degrees with other disciplines, e.g., computer science, public affairs, art history.

  Supporting: (Heim cited by Riggs and Sabine 1988, 55); (Marcum 1990, B3); (Hoadley 1986, 24); (Dougherty and Hughes 1993, 9)

Skills, attitudes, and personal characteristics:

- Recruit and nurture self-confident change agents and leaders.

  (Woodsworth and Lester 1991, 208)

- Create more aggressive, entrepreneurial types of professionals.

  Supporting: (Mason cited by Riggs and Sabine 1988, 71); (Lancaster 1983, 753); (Dougherty 1991, 61)

- Instill attitudes and values that are consistent with the notion that how and whether people in society get information is an important question.

  (Summers cited by Riggs and Sabine 1988, 68)

- Personal interaction skills for dealing with different constituencies.

  Supporting: (Cooper cited by Riggs and Sabine 1988, 55); (Vasilakis cited by Riggs and Sabine 1988, 68); (Asp cited by Riggs and Sabine 1988, 68)

- Compassion, understanding of people; people who like people; people-oriented, service-oriented people.

  Supporting: (Smith cited by Riggs and Sabine 1988, 74); (Strong by Riggs and Sabine 1988, 74)

- Instill lifelong learning skills.

  (Dowlin 1991, 320)

- Teach students how to be effective communicators — orally and in writing.

  Supporting: (Wisener cited by Riggs and Sabine 1988, 53); (Chisholm cited by Riggs and Sabine 1988, 53); (Summers cited by Riggs and Sabine 1988, 67); (Rosenthal cited by Riggs and Sabine 1988, 71)

Several of the skills, attitudes, and personal characteristics that library schools should develop and nurture in their students are the same as those suggested for librarians of the future generally (section 10.6) , for example, the ability to handle change, personal interaction skills, assertiveness, leadership skills.

Need for continuing education:

- "We should begin making commitments now to staff development and professional education that will carry us into the future."

  (Von Wahlde and Schiller 1993, 21)

  Also supporting: (Lynch 1992a, 37)

- Focus on utilization and application of technology.

  Supporting: (Chisholm cited by Riggs and Sabine 1988, 76); (Kelinson cited in "Librarian's job" 1990, 19); (John cited in "Librarian's job" 1990, 19); (Dougherty cited in "Librarian's job" 1990, 19); (Hoadley 1986, 24); (Dougherty and Hughes 1993, 9)

- "There hasn't been widespread recognition by the organizations that employ librarians that they will have to make an investment in their people to retool them for change."

  (Asp cited by Riggs and Sabine 1988, 77)

Several writers are mindful of the need for continuing education. Of prime concern is the need to improve staff understanding and knowledge of new technologies. William Asp offers a important barrier regarding continuing education.

10.8 Facilities

Providing a place for meaningful activities:

- "Libraries are more than user-friendly book warehouses, they are places where children (and others) can be led into reading, where inquiries can be handled, where local cultural groups can exhibit their products and where social groups with special needs or educational requirements can find appropriate resources. Because the need for these functions will continue to exist as will substantial demand for some classes of book materials in traditional form, and because local libraries will find a role in acting as entry points to the electronic system for those who for one reason or another are unable to access it on their own, the public library will probably remain in place."

  (Martyn 1991, 298)

Although the ability to access digital artifacts from anywhere and at anytime will reduce the need for buildings in the future, writers still maintain that libraries provide a place for meaningful activities — study, quiet reflection, story times, exhibitions, and entertainment.

- "Preserve the library as a place where people can meet, interact, and work."

  (Dougherty and Hughes 1993, 11)

- " ... Students will continue to find ways to disrupt serious study in the dormitory and other sites — particularly the library — will continue to be in heavy demand for serious reading in quiet spaces and for the use of computers in support of study, course work, and research."

  (Leighton and Weber 1989, 24–5)

- "A primary role of the public library, seldom addressed by scholars writing on the subject of computers and libraries, is the recruitment of readers ... The public library's story time is an important social event for young children and their mothers. Young adults and grown-ups also come to the library for many of the same reasons: to get out of the house, to hang out with people, to stumble across something new, to enjoy some quiet, even to get into trouble. People also come just to browse through the new fiction."

  (LaRue 1993, 15)

  Also supporting: (Gorman 1991, 5); ("Will libraries render" 1992, 565ff.)

Accommodating staff :

Space given to staff activities will decrease in the library of the future.

- Technical processing can be performed in areas remote from the library, carried out cooperatively (e.g., statewide systems), developed as a cottage industry, farmed out to public and private organizations.

  (Gorman 1991, 6)

- Have less staff work space ... have more user space.

  Supporting: (Woodsworth et al. 1989, 134); (Hoadley 1986, 23)

- "The large reference collection of thousands of volumes may in the future be reduced as more services are available and used online."

  (Leighton and Weber 1989, 25)

General recommendations about future facilities:

Here are several unrelated recommendations about future library facilities.

- "It is no longer practical to group technology around walls or pillars because that is the only location where power can be found. Telecommunications will have to be designed to allow users access to collections from within the building, from across campus or across town, or from around the world, 24 hours a day, seven days a week."

  (Epstein 1991, 114)

- "Above all, new library buildings will have to be flexible: flexible enough to contain new formats, new technologies, and new uses. They will have to be adapted to new uses without extensive remodeling ... Large, flexible spaces will best serve the library of the future."

  (Epstein 1991, 114)

- "In smart library buildings, multiple vertical shafts with horizontal distribution ducts will be common for adapting to future change. Designers will provide spaces, probably on each floor and in many cases several on each floor, for the equipment required to change from fiber optic transmission to coaxial or wire transmissions ... Wiring closets of the future will be air conditioned for they may house network servers."

  (Leighton and Weber 1989, 26)

- Facilities for using secondary information sources: advisors' workstations, room for preparing information profiles, light gallery, holograms, neons, laser, room for telemeetings, videotext, teletext, telecopying, telelecturing hall (with contact to lectures of the world), workstations for clients, equipment lending offices; facilities for using primary information sources: stations for information retrieval, rooms for demonstrations (perceiving knowledge in three dimensions), rooms for teamwork, watching videos and slides, listening to compact disks, changing exhibitions.

(Hirvikallio 1991, 16)

Envisioning the dream library of 1998:

In 1988, Don Riggs and Gordon Sabine asked librarians to describe their dream library of the late 1990s. Nearly all respondents focused on a physical structure. Here is a sampling of their responses.

- "The main library will have a relatively large collection, whatever formats those are in. The physical building itself will house a range of materials. It will also link electronically to other libraries around the world ... and will be able to receive and send all kinds of information ... People will continue to come into the library, but some will never come into it ... The new technology doesn't appear to replace, it expands at every level, so I don't think that what we'll have in 10 years are buildings that are not used. I think we'll have building that are used more than they are now."

(Mason cited by Riggs and Sabine 1988, 88–9)

- "Our job is to try to formulate a realistic vision for the twenty-first century ... It's not going to be easy and it won't be done quickly, but I think the future of the New York Public Library in the twenty-first century is going to depend on how well we integrate these branch and research functions of the library and how well we perform as a single library that serves the needs of all users ... The marble building with the two lions out in front. That says 'library' to millions of people when they see that image, and we use that image a lot, our lions and the facade of our building."

  (De Gennaro cited by Riggs and Sabine 1988, 91)

- "One of the major considerations is a physical plant that constitutes the tangible context for offering good service."

  (Rosenthal cited by Riggs and Sabine 1988, 92)

- "When people see our library building, they are going to think, gosh, I'd like to go into that, it looks really interesting. It looks like something dynamic is happening inside."

  (Goral cited by Riggs and Sabine 1988, 92)

- "I have a vision of this beautiful school library with bright colors, with lots of plants, lots of open space, lots of windows ... "

  (Whitney cited by Riggs and Sabine 1988, 93)

- "I see the school library well-staffed in order to give service .. I see the constant flow of classes coming in with the teacher and doing what it is they need to do."

  (Stepanian cited by Riggs and Sabine 1988, 95)

- "Are libraries really all that different than they were 10 years ago? They don't look all that much different in terms of the building. But we have added a lot in that time — video cassette activity ... compact disks for audio recordings. It seems like any new format for recording information that comes along for the consumer market finds its niche in libraries ... it's not something that replaces something else."

  (Asp cited by Riggs and Sabine 1988, 96)

11 Harnessing the true potential of information technology

- "Our users must become independent problem solvers who know how to use information resources to address the challenges that face them (which includes the challenges of educating and entertaining themselves), and that idea will shape the library of the future in ways we may not even be able to imagine today."

  (Penniman 1993, 17)

- "The advent of multi-media and new genres of integrated media will also provide the opportunity to blur the distinctions between network accessible versions of libraries, archives, and museums."

  (Atkins 1993, 3)

- "Our ability to process all this information is virtually unchanged from the time our ancestors emerged from the caves where they had scrawled primitive symbols on the walls."

  (Penniman 1992b, 40)

- "It's difficult to demonstrate the value of a book, or for that matter, of a library. It's what the mind does with all the bits and pieces that matters."

  (Eastman cited by Riggs and Sabine 1988, 27)

- "We are at serious risk of becoming a data-rich but information-poor society."

  (Galvin 1990, 2)

- "The mere fact that there is more data available does not mean that people either want it or can use it meaningfully.

  (Schuman 1990, 35)

The quotations in this section are not necessarily related to one another. As you read them, envision the potential of information technology to enable people to do much more than merely increase productivity.

12 Whither libraries?

12.1 Paradigm shifts and an uncertain future

The paradigm shift from ownership to access (section 3.2.4) has been instrumental in forcing librarians to speculate about the future. In the near term, the future will be a "mixed bag" of print materials and digital documents. When librarians handle books, journals, maps, scores, and so on, they will be dealing with physical objects for some time to come. At the same time, librarians will have the opportunity to gain access to digital representations of these items.

Generally, the first generation of digital items will be nothing more than digital representations of physical objects. Intellectual property holders, publishers, librarians, for-profit and not-for-profit organizations will mount digital documents on servers and wait for end users to request them. How will users learn of the existence of these items? Most likely through the same channels as they learn about them today — that is, they will retrieve abstracts from searches of abstracting and indexing databases, query full text digital document databases, find items cited in other publications, ask colleagues for leads, and so on. Although some end users will want the digital file to manipulate on their own, it is doubtful that intellectual property holders will allow them to have it because of the ease with which copies can be made and distributed to others. Thus, in response to requests for particular items, libraries will provide users with printed copies of digital documents. Libraries will also provide remuneration to intellectual property holders or intermediary organizations that such holders designate to accept remuneration on their behalf.

Digital library projects such as TULIP and Project Mercury are prototypes of this vision for the near future. Although such projects have targeted journal literature, we can extend this scenario to full-length works such as monographs and large-scale reports because of advances in photoduplicating technology such as Xerox's Docutech Publisher Copier that is able to copy and bind whole books in the matter of minutes.

Clifford Lynch (1992b, 111) characterizes digital library projects with the statement, *"The experiments we are seeing today are basically conservative. They are*

very close to the print tradition." However, these projects are a necessary step in the progression toward digital libraries because they involve the various digital library stakeholders — publishers, librarians, digital library systems designers, end users. They also address specific, concrete problems that will help to define some important principles within the complexity of the digital library problem including definitions of digital library stakeholder roles.

Close on the heels of the paradigm shift from ownership to access will come another, more important paradigm shift. This shift will feature new modes of communication that cannot be represented on paper. Such modes will be changeable, interactive, non-linear, bear sound, color, video, talk to one another, have no final beginnings, middles, and endings; someday we will even be able to walk into and participate in them. *When primary artifacts feature modes of communication that cannot be represented on paper, the real revolution will begin.*

This revolution will be scary for the various parties involved in scholarly communication. Publishers will be concerned about finding the right products at the right time. That is, they fear making huge investments in new technologies and products and watching end users remain in old paradigms, content with old products. Yet, if publishers wait too long, the market may pass them by for competitors' more desirable products before they can enter the market with comparable products of their own.

The consequence of placing digital artifacts in the hands of end users that concerns intellectual property holders is the predilection of end users to make and distribute copies of the original, thus, depriving intellectual property holders of remuneration. Why would end users be tempted to do this? Consider how easy end users obtain information from libraries today. They borrow materials or make photocopies of them. They rarely associate a price tag with access to library materials. Consider the transparent nature of digital artifacts. End users will not need packaging or manuals to manipulate digital artifacts. Purchasing digital artifacts could be as easy as dragging them or their icon between windows on a computer monitor and responding to a warning that the supplying server is debiting the requester's credit card. (For rabid shoppers who enjoy unwrapping fancy packaging, fighting with shrinkwrap, or opening sacks, purchasing digital artifacts will be a real drag!) There are many people who prefer to buy software because software publishers package materials in attractive dustcovers and supply helpful printed manuals. When end users purchase digital artifacts, they will not even experience the simple pleasure of unwrapping packages or handling an attractive printed manual or dust cover. They might ask themselves why purchase the artifact when they can get the real thing free from friends or colleagues? The illegal duplication of software that goes on today is evidence that such duplication is likely to extend to digital library environments.

The same consequences of placing digital artifacts in the hands of end users frightens authors. Consider the effect that unauthorized distribution could have on future digital artifact "best sellers." When one person purchases the latest best seller, they can place it in the electronic in-boxes of friends and family and everyone can enjoy it — except the author who is missing out on royalties from purchases. A primary concern of authors is the ability to change artifacts and disseminate altered copies. This concern brings to mind a not-so-recent incident in which the publication of a sex manual contained a major error in the discussion of the days of the month women are most likely to conceive; the publisher recalled the manual and published a corrected version. Consider the changes that vandals could wreak on digital artifacts. Tampering with digital artifacts in medicine, engineering, and other scientific fields could cost lives. Lawsuits would ensue. What a mess!

It is entirely possible that the problem of data integrity is more a perceived threat than real. Encoding strategies (e.g., "putting artifacts in a shield") may prevent this problem from occurring. The fact that tampering is perceived, however, slows the growth of digital libraries.

The primary concern of librarians is that digital artifact production and dissemination will leave them totally out of the picture. Librarians are concerned that intellectual property owners so fear unauthorized distribution of digital artifacts that they will market them directly to end users. A variation of this scenario places librarians in an intermediary role in which they track digital artifact usage by end users and remunerate intellectual property holders for use. Librarians would not be happy with this role because restrictive licensing agreements will probably not allow archiving of licensed digital material. Furthermore, a principal *raison d'être* for libraries — the preservation of knowledge — would be endangered under such agreements. Another major concern is the future of interlibrary loan. Licenses, contracts, and other formal agreements between libraries and intellectual property holders regarding use of digital artifacts could preclude distribution to third parties through interlibrary loan.

End users probably have no idea of what is coming. Imagine the parents of college students dishing out several thousands of dollars on top of tuition and other college expenses so that Johnnie can create his own digital artifact based on up-to-date digital artifacts he purchases through the library's server and submit it for a grade to his professor. Voracious academic library users are impoverished graduate students working on dissertation literature reviews. Occasionally university faculty have grants they use to defray the cost of acquiring digital artifacts; faculty at teaching colleges may not be as fortunate. Consider public library users, the reasons why they use the library, and their ability to pay for information. Yet, there is some consolation in the realization that as markets for digital artifacts develop, costs will eventually drop.

Underlying the consequences of the digital artifact paradigm shift is the assumption that the acquisition-on-demand model will govern access to such artifacts. To be successful, there must be a sleeping beast of demand for digital artifacts. Will there be such a demand? Yes — millions of households will clamor for digital *entertainment* artifacts. In fact, the potential of the demand for the former is so great that it is forcing mergers and acquisitions of huge corporations such as telephone operating companies and cable television to amass the critical enabling technologies to supply the beast of demand to come. And the demand for *scholarly* artifacts? The authors feel the demand will be small to moderate and much of it will come from libraries.

Many of the problems connected with digital artifact dissemination will be solved by players in the entertainment artifact business. That is, if scholarly presses are concerned about unauthorized distribution and alteration of digital artifacts, so are the giant corporations that are positioning themselves for the entertainment market. The latter will marshal the resources necessary to develop an encryption technique that forbids the creation of unauthorized copies and unauthorized alteration of originals. This technique should allow purchasers of digital artifacts to transfer them between media or machines. For example, an individual might have purchased a digital artifact several years ago and want to transfer the artifact from their old machine to a newly purchased computer.

Digital artifact authors will not contest the encryption of their works. This will save them from the anxiety of both unauthorized reproduction and alteration of their works.

In the best of possible worlds, encryption would not be necessary. Digital libraries would feature access to entire artifacts. Descriptive cataloging would be automatic. Searching would be done on entire artifacts. Artifacts would talk to other artifacts and establish connections between themselves. Unfortunately, encryption techniques will be necessary for the reasons given in this and previous sections. These techniques could severely limit access to digital artifacts. While intellectual property holders could be convinced to leave certain artifact components unencrypted, i.e., digital title pages, tables of contents, and other helpful artifact navigation devices, they will probably apply encryption techniques to the majority of artifacts. They may allow purchasers to extract a certain percentage of artifact contents for incorporation in other artifacts. Librarians should demand access to unencrypted digital artifacts to enable them to establish connections between digital artifacts to facilitate searching and browsing. Ultimately, such connections will benefit intellectual property holders because end users will be more likely to find and use their works and use will generate revenue for intellectual property holders.

12.2 Access to scholarly information in the future

What does the future hold for digital libraries? In their vision of the future, the authors are influenced by the future Clifford Lynch (1993, 12) describes:

> Imagine a world where there are many more dissemination channels for information, ranging from traditional print publications to a wide array of network information distribution options. We will have free information, information that we are paid to read (advertising, basically), information that is sold to recover costs, information sold for a profit, information the price of which decays as the timeliness of the information itself lags, and information the value of which varies inversely or directly with the scope of its distribution. The number of pricing options will be as wide as the set of motivations for making information accessible.

Although access to scholarly information will prevail under all the models discussed in section 7 and the ones Clifford Lynch describes above, the authors feel that three models will prevail: (1) vanity press model, (2) noncommercial publishing model, and (3) acquisition-on-demand model.

The vanity press model is very much a reality on the information network right now. A large number of creators of digital artifacts — scholars, researchers, students, and others — want to share their creations with other network users. They may be concerned less about alterations or copying than the advantage of the speed of the network to disseminate their creations to interested colleagues. They may also want others to share in the experience of their creation.

Creators might not have access to a public server to mount their artifacts. Also, after a period of time, they may lose interest in maintaining their artifact in a public workspace. For any number of reasons, creators could eventually (or initially) submit their creations to an on-campus or remote digital library. Libraries might have a qualifying procedure for digital artifacts. They would be responsible for maintaining qualifying (or submitted) artifacts, publicizing archive contents, making hypertext links between newly submitted artifacts and related ones in other libraries, providing searching capabilities, and allowing interested searchers to copy artifacts to their private workspaces. This description of the noncommercial publishing model is not as all-encompassing as its advocates would like it to be (sections 7.1 and 7.2); however, it will offer unlimited access to much material in the public domain.

The authors believe that the acquisition-on-demand model will drive *formal* scholarly communication in the future. Refereeing and editorial review of digital artifacts will be facilitated through network communication capabilities. When editors accept digital artifacts, creators will transfer or share intellectual property rights with publishers. In the editorial process, editors will probably add conventions to artifacts that are characteristic of the publishing house. In terms of publication and dissemination, any number of scenarios are possible. Some publishers might

engage intermediaries to distribute digital artifacts or artifact notifications to libraries and to other account holders. Some publishers might interact directly with their account holders including libraries. To simplify operations and logistics, librarians would probably prefer interacting with a few intermediaries rather than large numbers of publishers.

When the intelligent agents of publishers notify library collection development agents of newly published material, the latter agents will be profiled to accept addresses of newly published artifacts from certain publishers sight unseen. Other library agents would automatically perform all descriptive cataloging functions, and, possibly, enlist librarians to review their decisions regarding subject cataloging and the creation of intellectual links between newly published artifacts and other artifacts to which the digital library provides access. Collection development agents will also be profiled to inform collection development library staff of the availability of newly published artifacts from certain publishers that are not accepted sight unseen and must undergo manual review by such staff.

Governing access to artifacts in digital libraries will be licensing agreements between publishers and libraries and/or between intermediaries and libraries. Agreements will spell out the terms of remuneration for various uses of transferred artifacts.

In the digital library environment, universal access is a distinct possibility because library material will be accessible through the information network. Unfortunately, universal access may be a difficult goal to achieve because of the cost of the many licensing agreements libraries must negotiate with intellectual property holders. We can, however, envision a future in which digital libraries claim to provide universal access but pay premium-level charges (or pass charges onto users) for access to library material for which the library has no licensing agreement.

Since digital libraries will perform descriptive cataloging tasks automatically, library staff will turn their attention to the creation of intellectual connections between newly published digital artifacts and the general artifact collection. This means much more than assigning one or two subject headings per artifact. Librarians will establish connections that enable end users to make informed decisions about acquiring artifacts. Connections need not be limited to *formal* scholarly communication channels. Librarians should mind *informal* scholarly communication channels such as list serves and discussion groups for pertinent discussion that covers the topics in *formal* communication or refers to specific artifacts directly. To accomplish this, librarians will have to call on computer-based intelligent agents such as knowbots to assist them in scouring the volumes of chatter on the network.

"On a network, to read is to own" (Seiler 1989, 69). The authors do not feel that such stringency will wash on the network. End users will want intelligent agents to navigate digital library artifacts, pinpoint relevant passages in a split second, even talk

to other artifacts based on digital artifacts or passages in digital artifacts that users have deemed relevant. End users will demand the same opportunity to inspect digital artifacts as they do for purchases of other items. They will not purchase digital artifacts sight unseen. How many end users already have the unhappy experience of carting home heavy books and gobs of photocopied articles from libraries only to discover that they will not be as useful as they first thought? Before making a purchase, end users will spend much time scrutinizing digital artifacts.

When end users copy a digital artifact onto their computers, they will be purchasing it. A message will warn them that their credit card is being debited. Encryption techniques will ensure that end users cannot alter purchased artifacts or make copies to distribute to their buddies.

Libraries could subsidize the purchase of digital library materials. Academic libraries could defray the cost of staff, faculty, or student purchases by monitoring the computer account that makes the purchase. Public libraries could allow members of the community to purchase digital artifacts until they exceed a certain amount of money. It is entirely possible that artifact borrowing in public libraries could be comparable to borrowing traditional library materials. Many public library users might have to borrow special electronic readers to access digital artifacts. The artifacts they select would be placed on readers that disable altering or copying functions. Borrowers would be required to return readers to the library. When the borrowing period expires, digital artifacts would vanish from borrowed readers. Although this scenario of public library borrowing does not take advantage of many of the unique capabilities of digital artifacts, it provides users with the opportunity to experience and learn from digital artifacts.

For a while, library users will access digital artifacts for the latest information. They will turn to paper-based collections for retrospective coverage of their topics of interest. At any time, intellectual property holders could "pull the plug" on access to not-so-recent or unused digital artifacts. That is, they will no longer support network access to these artifacts. How will searchers get access to such digital artifacts? In time, it will become increasingly apparent that a large gap between current and retrospective information exists.

Librarians must jump on the opportunity to preserve the knowledge of our civilization. They should make it beneficial for intellectual property owners to hand over digital artifacts that they no longer want to maintain to libraries. Librarians could mount such artifacts on servers, track patron usage, and make royalty payments to intellectual property owners. Such payments would be at a lower rate than levels set for access to the latest digital artifacts because librarians would subtract costs connected with digital storage on the network and with data conversions as artifact formats evolve over the years to handle new capabilities. Thus, publishers would still earn revenue from older digital materials and libraries would

fulfill their role as preservers of knowledge. Tax incentives may be necessary to encourage intellectual property holders to hand over digital artifact files to libraries when they determine that they can no longer make a profit from providing access to such material.

Digital libraries that perform archival functions for intellectual property owners might limit their coverage to particular subject areas. They could also be regional libraries that are administered by states, educational consortia, and so on. Today's bibliographic utilities may envision themselves performing such a role.

12.3 Libraries and librarians in the future

For a while, library users will rely on the paper collections that libraries have amassed over the years. As information is increasingly produced in digital artifact form, they will turn toward digital artifacts. Since library users can preview digital artifacts anywhere and at anytime, they may quickly prefer them over traditional library materials that they must track down on library bookshelves. Paper collections will slowly fall into disuse and large portions of such collections will be warehoused at remote locations. Libraries will still collect some proportion of the small share of information that is published in paper formats. It is entirely possible that the very prominence of digital artifacts will bring about a Renaissance in the production of quality books that people value for their beautiful bindings, typography, paper stock, and so on.

The authors believe that libraries will continue to be associated with buildings. Although physical collections of books, journals, and other materials will no longer consume valuable space in these buildings, we can envision the need for workspaces where users consult library resources on state-of-the-art computer workstations; study spaces where users demand quiet for contemplation and reflection; large, medium, and small sharing spaces equipped with state-of-the-art equipment to enable groups to incorporate technology into their gatherings. Seija Hirvikallio (1991, 16) describes facilities for libraries of the future:

> Advisors' workstations, room for preparing information profiles, light gallery, holograms, neons, laser, room for telemeetings, videotext, teletext, telecopying, telelecturing hall (with contact to lectures of the world), workstation for clients, equipment lending offices, ... stations for information retrieval, rooms for demonstrations (perceiving knowledge in three dimensions), rooms for teamwork, watching videos and slides, listening to compact disks, changing exhibitions.

A few reference staff will be physically present in the library building to assist users in person in collection navigation. Most reference staff will be posted on the network where they will respond to user calls for assistance by monitoring a user's ongoing

search. Such calls could come from users who are navigating digital libraries from workstations in their home, dormitory rooms, or offices. Imagine conducting a search from your home computer on a Sunday night, getting frustrated over it, pressing a hot key to summon a reference librarian, and holding a teleconference in a window of your monitor where you can see and talk to the librarian and s/he can see and talk to you and eavesdrop on your search. Staff could work out of their homes because they would use the capabilities of the information network to interact with users. Although technical aides will be physically present in the library building to help library users with computer equipment, there will be few staff physically present in the building. Since licensing agreements could make resource sharing difficult to impossible, it is entirely possible that a few technical services staff take turns performing interlibrary loan functions.

Public library environments would feature itinerant reference staff whose duties resemble today's information brokers. These individuals would market their services directly to small- and medium-sized businesses. They would not be limited to a particular locale or region because they can interact directly with their clients via the information network. Staff might specialize in services to organizations that do business in areas that the library collection emphasizes. For example, in southeast lower Michigan, digital libraries are likely to have strong collections to serve the automotive industry and itinerant librarians would provide information services that feature such collections to businesses in the automotive industry regardless of their geographic location.

For a while, academic libraries would support the posting of reference librarians to particular schools and departments. Gradually, schools and departments would assume support for these positions. Librarians would interact directly with students, faculty, and research staff, learn the culture of the particular unit, understand the various research methodologies that the field employs, discover the specific research interests of faculty and research staff, and identify the strategies that they use to satisfy their information needs. Reference librarians would develop specialized informational tools to assist unit members in network navigation. For example, librarians who are posted to an engineering department where faculty, staff, and students are conducting research on solar-powered motor vehicles would customize navigational tools-of-the-day (e.g., Mosaic, Gopher) to draw their attention to formal (i.e., digital artifacts) and informal (e.g., bulletin boards, list serves) in this area. Librarians would also help users profile intelligent agents to scour the network on their behalf searching for scholarly communication on topics that interest them.

The physical location of future technical services staff will not be important because they will increasingly work with digital artifacts located on the network. In time, divisions between acquisitions and processing staff will disappear. Both will spend considerable time surfing the network for useful informal communication, responding to the findings of intelligent agents that they enlist to scour the network,

and evaluating formal and informal communication. Increasingly, staff will spend less time on the creation of document surrogates because computer programs will manipulate digital artifacts and create them automatically. Staff will spend more time summarizing the intellectual contents of digital artifacts, establishing and building intellectual links between digital artifacts, and surfing the network for new communication. Technical services staff and remote reference staff — itinerant, school/department, and library reference staff — will work in virtual teams to learn about the information needs of end users so that they can effectively evaluate available resources for potential inclusion in the digital library collection.

Libraries will establish an intellectual property office staffed with professional librarians and attorneys. This office will handle licensing agreements with intellectual property holders, forward remuneration for artifact usage to them, serve as a source of information for systems staff whose systems control access to digital library artifacts, and act on staff requests for information resources that require new licensing agreements.

The digital library will be a network of information servers. Some servers will be located onsite, that is, in office space in a public or academic library building. Most servers will be located in businesses, libraries, universities, and organizations around the world. With respect to onsite servers, digital library systems staff will maintain databases of document surrogates produced by abstracting and indexing services and digital artifact previews produced by publishers. Since some publishers may be reluctant to allow end users to preview entire digital artifacts, surrogates and publisher-supplied previews may be necessary to assist end users in artifact selection. Surrogates will also be produced for licensed digital artifacts or public-domain artifacts by automatic procedures such as the application of computer programs to designated artifacts. Onsite databases will include intellectual connections between surrogates or artifacts that are established by technical services staff. Connections will be represented in hypertext links (or some other technology-of-the-day) that facilitate navigation between artifacts, surrogates, and previews.

Libraries will negotiate licensing agreements with specific intellectual property holders and with intermediaries that act on the behalf of many property holders. Generally, such agreements will enable libraries to provide their users with access to digital artifacts. Intellectual property holders may want remuneration everytime a user previews a digital artifact and/or transfers an artifact to their private workspace. They may also vary remuneration based on the amount of time users spend previewing artifacts before downloading them. Publisher-supplied previews and digital artifacts could reside on a publisher's server, intermediary's server, or libraries could arrange to mount the artifacts on their own servers. These are three possible scenarios and there will be many more. Creators will not require remuneration for public-domain digital artifacts, and such artifacts will be located in servers around the world.

When digital library users sign on to their particular library's information network, they will not have to identify themselves to acquire public domain materials. Identification will be necessary to access licensed materials. Users can navigate general knowledge structures or choose customized structures devised by reference librarians posted to their schools, departments, and colleges. Their searches will retrieve document surrogates, previews, and, public-domain digital artifacts. In public libraries, we can imagine customized structures devised for certain age groups such as children, young adults, or seniors. Librarians could also develop customized structures to assist students who are working on projects on certain themes or events, e.g., "Earth Day," "World AIDS Day," "Great American Smokeout." Navigating knowledge structures, end users will eventually identify surrogates or previews of interest connected with licensed digital artifacts. They might want to review digital artifacts prior to acquisition. The extent to which library systems allow users to review digital artifacts may be governed by licensing agreements. Thus, users might be limited to selected components of digital artifacts or be able to browse entire digital artifacts for a limited period of time.

When end users drag a digital artifact icon into their personal workspace, the library system would warn them that it was debiting their credit card for a certain amount and allow them to verify the transaction. Lower transaction rates could be associated with one-way loans of digital artifacts. For example, users could choose from a menu of expiration times the length of time they needed to access desired artifacts (e.g., 24 hours, 48 hours, one week). When the time period expired, the digital artifact would delete itself from their personal computer workspace. Although this expiration capability is not available today, the for-profit electronic entertainment industry may have to develop such a capability to support electronic video rentals and compete with manual video rentals. The most important point about digital artifact transactions between library systems and end users is that the library, end user, or both will remunerate intellectual property holders for artifact use.

Just like the automated library systems in the late 1970s and early 1980s, digital library systems of the 1990s are experimental or demonstration systems. As technologies mature and the roles of the various digital library players become clear, for-profit vendors will market digital library systems so that individual institutions can customize their digital collections to their constituencies. It is also possible that intermediary organizations will market digital library services to small- and medium-sized institutions that do not want to make a commitment to a digital library system until the dust clears with respect to system development and librarians have sufficient experience with digital artifact management.

12.4 Staking claim to new territories in the digital future

While digital communications is in a formative state, librarians have unprecedented opportunities to stake their claim on entirely new territories. If librarians do not make their claims, some other groups will take charge. This section describes five areas where librarians must stake claims to ensure roles in the digital future.

The first claim is suggested by Clifford Lynch (1993, 18–19). He advises librarians to stake their claim to the organization of public-domain communications:

> On the network today there is a jumble of information that is ephemeral in character and information that is of lasting value. There is a compelling need for information-organizing technologies that accommodate not only the long-term information but also the ephemeral. It seems appropriate that libraries and the information science research community should undertake the research necessary to develop techniques to manage this rich but chaotic collection of information. Traditional cataloging is probably not the answer, and certainly not the complete answer … One would speculate that part of the reason that libraries have not emphasized this material is that it is unclear how to organize it, provide intellectual access to its contents, and to deliver it effectively to large numbers of patrons … The traditional publishers, as well as the libraries, have largely avoided becoming involved in the early fruits of the coming transformation of scholarly communication.

Throughout this discussion of the future of libraries, the authors have cited public-domain digital artifacts and *informal* scholarly communication. This is precisely the information that Lynch is encouraging librarians to organize. Organizing informal communication will require librarians to make links to formal communication. In the course of organizing such communication, librarians are likely to find the distinctions between the two forms of communication become blurred and an entirely new form of communication will emerge that is a blend or concoction of the two or an entirely new form of literature.

Richard Lanham's (1990, 35) discussion about preparing college students to live in the real world touches upon the second claim:

> If we want to prepare our students for the world out there, it must be a new kind of preparation for a very different world. What would a Freshman Composition Handbook look like if it were a guide to the world of electronic text rather than print? What first principles would it avow, and what practices would it advise?

For a while, librarians will have the opportunity to help scholars express their ideas in terms of new information technologies. Learning these new technologies is imperative. Library school researchers (present company included) should be among the first to file integrated media reports to project sponsors. Library schools should not stand by and watch but they should be right in the thick of the action offering

continuing education courses to help active practitioners learn new technologies. Returning to their workplaces, practitioners should offer their expertise to established research teams and teams in the formative stages. For example, they could transform the findings of the former in an integrated media show that the research team shows to officers of a private foundation in an attempt to secure additional research funds.

The third claim centers on digital artifacts that intellectual property holders no longer consider profitable. Anita Lowry (1993, 70–1) suggests that librarians can play an important role in preserving the intellectual record of our culture.

> Can we rely on the information industry to preserve access to specialized or historical data that is no longer deemed economically viable? I doubt it. Does this imply ever greater roles for libraries and library consortia or utilities in regaining control over specialized and scholarly databases and database back files that the information industry will not support? I think so.

A variety of methods has been suggested for responding to this opportunity. Dennis Dillon (1992, 513) calls for tax incentives to stimulate publishers to supply libraries with their unprofitable works. Brian Hawkins (1993, 15–16) calls for the creation of an independent non-profit organization — *"a single focal point for negotiations and central brokerage, eliminating unnecessary costs and duplication, leveraging resources, and promoting standards."* In view of the interest in electronic publishing among members of the Coalition for Networked Information (CNI), this group could become involved. The corporation for public networking that Nancy Kranich is advocating to ensure public "space" in the emerging national information highway could be enlisted to encourage publishers to transfer unprofitable works to libraries (Kranich 1993, 35). Perhaps all the methods and organizations described here will be needed to convince publishers that supplying libraries with their unprofitable works would be an admirable and worthy public service.

The fourth claim is to ensure public access to the national information network for libraries and other educational institutions. Nancy Kranich (1993, 35–6) expounds on this claim:

> The proliferation of commercial and entertainment ventures, of rampant retailing, have put the opportunity for alternative voices, public interest and government information, research, and interactive education at great peril. If not controlled, industry giants will transmit 500 or more channels of highly profitable, entertaining vaporware that will fall far short of serving the full spectrum of society's needs … The new national information infrastructure must ensure 'public spaces' that are filled by educational and research institutions, libraries, nonprofits, and governmental organizations charged with promoting and fulfilling public policy goals.

The corporation for public networking that Nancy Kranich proposes will not come about on its own. Librarians, educators, public interest groups, professional societies (e.g., American Library Association, EDUCOM), and consumers must work together to ensure public access to the national information infrastructure. Perhaps the independent non-profit organization that Brian Hawkins proposes may also assume an important role in the fight for public access. If librarians sit this one out, *"our new information infrastructure may be dominated, accessible, and affordable by just a privileged few"* (Kranich 1993, 37).

The fifth claim includes all players in the digital library future. This is an intense time of development, experimentation, demonstration, and refinement. Librarians must seek every opportunity to work with the other players, learn about and understand differences, appreciate the value each player brings to the table, and work together to resolve issues of concern in ways that benefit each player. It will simply not do to shut one or another player out of the digital scholarly communication process. Clifford Lynch (1992b, 108) makes the following observation:

> There is, without doubt, a conflict of interest among the stakeholders in the current system of scholarly communication. Today we have a balance of these conflicting interests that is working less effectively each day. Finding a new balance will require both cooperation and (constructive) confrontation. It is clear that there are well-entrenched vested interests, including publishers, academics, and attorneys, in the current state of affairs. This is a multi-billion-dollar business, and the players want only to move the current balance modestly and slowly.

Too much is at stake to hold up development and implementation efforts while individual players settle lawsuits that result from their pursuit of parochial interests. Digital information will improve this country's ability to compete in a global market. It will lend sorely needed support to the improvement of our educational system. It will transform the way in which we work and help us to think in more productive ways.

13 A Sense of Urgency

> If one assumed that the number of electronic journals would grow to 100 by 1995 and 1,000 by the year 2000, they will still account for only a small proportion of the estimated 7,000 to 15,000 scholarly journals in existence. This is not something … that is going to inundate us anytime soon. (Dillon cited by McDonald 1991, A6)

Martin Dillon's comment about the growth of electronic journals could give many in the library community a false sense of security about our future. That is, until this new form of communication accounts for a sizable portion of published literature, we can sit back and wait a while. If we *do* wait — even a year or two years — we will have missed our opportunity to involve ourselves with the large corporations that are now making crucial decisions that will affect access to scholarly information in libraries. Lest you think that large corporations are not thinking about electronic journals, consider the partners in the digital library projects list in section 9 — Springer-Verlag, McGraw-Hill, Elsevier. Consider also the mergers and acquisitions of huge corporations such as telephone operating companies and cable television that are positioning themselves for the coming electronic revolution.

It is absolutely critical that librarians become involved with discussions at all levels regarding access to digital artifacts. Even if librarians become nothing more than nagging irritants in the eyes of decision makers at large corporations, librarians must convey their requirements regarding access to information. Many of the decisions that will be made will not be acceptable to the library community. However, we must make it clear to decision makers that we will be a force to be reckoned with today, tomorrow, and in the future.

The digital library environment will require librarians to take on unprecedented new risks as they experiment with new forms of communication and new technologies, establish new policies and procedures, and collaborate with new partners who will not be operating under the same values, intentions, and goals as themselves. Change will be the bellwether of the digital library environment. Librarians must seek every opportunity to retool themselves in the technology-of-the-day with a view to the technology of the future. Sitting back and wondering *when* the library of the future will arrive will just not cut it in a future in which technology is setting the pace. The library of the future is happening *now* as *we write this review*. Let's join together with

various stakeholders, collaborators, and partners, roll up our sleeves, and work together on creating the library of the future. The direct involvement of librarians in the creation of the digital library will be necessary to ensure that this new form of library reflects our own values and that our values are not replaced by those of other professions or stakeholders.

There is no time like the present to begin shaping the future in which we will live and work.

- "Securing the information future is just a bit more important than securing the information past."

  (Billings 1991a, 42)

- "Even more important than setting forth a vision is to begin to focus on how we will develop and maintain organizational adaptation mechanisms. Rather than wait until finality is thrust upon us, we should begin this work today. For only if we continually evaluate and adapt to the evolutionary changes will our future take care of itself. If we fail to meet the challenges, the future will take care of us."

  (Hirshon 1993a, 7)

- "We must shape the future, not let it shape us."

  (Penniman 1992b, 40)

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